ACCELERATING CIVILIAN REACTOR PROGRAM

HEARINGS

BEFORE THE

JOINT COMMITTEE ON ATOMIC ENERGY

CONGRESS OF THE UNITED STATES

EIGHTY-FOURTH CONGRESS

SECOND SESSION

ON

PROPOSED LEGISLATION FOR ACCELERATING CIVILIAN REACTOR PROGRAM, S. 2725 AND H. R. 10805

MAY 23, 24, 25, 28, AND 29, 1956

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ACCELERATING CIVILIAN REACTOR PROGRAM

WEDNESDAY, MAY 23, 1956

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D. C.

The Joint Committee met at 10 a. m., pursuant to notice, in room P–63 of the Capitol, Senator Clinton P. Anderson (chairman of the Joint Committee) presiding.

Present: Senators Anderson, Pastore, Gore, Jackson, and Bricker; and Representatives Holifield, Price, Cole, Van Zandt, Hinshaw, and Patterson.

Present also: James T. Ramey, executive director, George Norris, Jr., George E. Brown, Jr., Wayne P. Brobeck, and David R. Toll, of the Joint committee staff.

Chairman ANDERSON. The committee will be in order.

Today we begin hearings on proposals to accelerate the civilian reactor program, including consideration of S. 2725 introduced by Senator Gore and H. R. 10805, an identical bill, introduced by Representative Holifield.

It might be well for the record to insert at this point the text of the above bills introduced by Senator Gore and Representative Holifield.

(The bill referred to follows:)

A BILL Authorizing and directing the construction by the Atomic Energy Commission of six nuclear power facilities for the production of electric power

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That (a) the Atomic Energy Commission is hereby authorized and directed to construct six nuclear power facilities designed to demonstrate the practical value of utilization facilities for industrial or commercial purposes pursuant to section 31 of the Atomic Energy Act of 1954.

(b) Each such nuclear power facility shall, insofar as feasible and practicable, be of a different design, each design being selected on the basis of a determination that the construction of a facility so designed gives promise of making a significant contribution to the advance of the science and technology of the commercial and industrial aspects of the atomic energy program.

(c) Each facility constructed under authority of this Act shall be located in a different geographical section of the United States. In selecting sites for each facility, the Commission shall consider the suitability of the proposed reactor type for the particular location and the need for additional electric generating capacity in the region of the site under consideration.

(d) It is hereby declared to be the intent of the Congress that the full resources of the United States should be made available to advance the art of generation of electric energy from nuclear energy at the maximum possible rate. The reactor construction program authorized by this Act shall be in addition to the reactor development program being carried out by private or public groups under licenses authorized by section 103 of the Atomic Energy Act of 1954.

SEC. 2. There are hereby authorized to be appropriated such sums as may be necessary to carry out the provisions and purposes of this Act.

Chairman ANDERSON. At a later point we will insert in the record, or have it read, the letter from the Atomic Energy Commission. Generally these reports of the agencies are inserted and commented upon, and I think perhaps it would be well to have the record include the letter from the Atomic Energy Commission.

As you know, we have concluded hearings on legislative proposals for governmental indemnities or insurance to protect the public and reactor operators against reactor hazards. In those hearings we identified some of the other possible roadblocks, primarily legislative or administrative, to private atomic development.

In a floor statement on May 9, I attempted to place the two sets of hearings in proper perspective and would like to insert this statement in the record at this point as a means of providing a partial framework for the hearings.

(The statement referred to follows:)

SPEECH BY SENATOR CLINTON P. ANDERSON, CHAIRMAN OF THE JOINT COMMITTEE ON ATOMIC ENERGY, DELIVERED IN THE SENATE, MAY 9, 1956

Mr. President, the Joint Committee on Atomic Energy is about to begin hearings on some fundamental problems which may well affect the future of the entire peacetime atomic energy program. These hearings were announced in my floor statement on April 26, 1956, and are scheduled to commence next Tuesday, May 15. Today, I would like to say a few words more about their importance and about the objectives we hope to accomplish.

Two bills before the committee, H. R. 9701 and H. R. 9802, concern the question of public liability, or insurance, of companies engaged in the atomic energy program. As you know, the Atomic Energy Act of 1954 was intended to encourage private industry to construct and operate nuclear plants for the generation of electrical power. The progress in this field to date has been slower than anticipated. During the past year the committee has been informed by private utilities and equipment companies that certain problems must be solved before they can proceed in the atomic power field.

Chief among these problems is the question of liability to the public of manufacturers and operators of nuclear reactors in the very remote event of a reactor accident. The two bills before us are intended to provide the needed protection for the companies against unlimited liability. We have invited interested parties to testify, and we have requested industrial witnesses to disclose any other roadblocks which they believe stand in the way of progress of private industry in this very important field.

After considering the insurance problem, we will commence public hearings on Wednesday, May 23, on S. 2725, known as the Gore bill, and on other proposals for accelerating the civilian reactor program. The Gore bill authorizes and directs the Atomic Energy Commission to build six nuclear power reactors to assure advancement of the nuclear art, either in addition to, or in the absence of, private industrial participation.

As you know, Mr. President, there has been mounting concern both within the Joint Committee on Atomic Energy and elsewhere as to whether or not the United States can maintain its position of world leadership in the industrial and other peaceful applications of atomic energy, especially in view of significant progress reports made by the Soviet Union, and by our friends in Great Britain and France.

The Joint Committee has been continuously studying the world picture and our domestic status in the atomic energy field during the 84th Congress.

Thus, the committee members attended and observed the many interesting developments demonstrated at the International Conference on the Peaceful Uses of Atomic Energy at Geneva last summer. Also, following this, a panel of leading citizens, organized by the committee and known as the McKinney panel, studied and reported on our status and our future.

In addition, the committee conducted public hearings during the first 60 days of this session, in accordance with section 202 of the Atomic Energy Act, in order to study and hear testimony on the growth, development, and future of the atomic energy industry. Following this, we conducted public hearings on the report of the McKinney panel.

In addition to these efforts, the committee conducted an informal advisory seminar to explore, with the help of many interested parties, the question of public liability as it affects civilian reactor progress. This seminar was most constructive in that it permitted the committee to receive a frank presentation of industry's views on this serious matter.

The time is now at hand, Mr. President, for our committee to place the whole situation in perspective, to examine the issues before us, and to provide congressional leadership in setting further objectives and policies to guide our civilian atomic energy program. Although consideration of the insurance problem has delayed congressional analysis of the whole civilian reactor problem, it is my hope that some action on both fronts can be taken in the present session of Congress. We cannot afford further delay. It is time that we attain a position where we may offer to the people of this country and to the free people of the world a product which is both advanced in concept and in being—not just paper plans and promises.

Our committee proposes to proceed in the following manner:

First, we feel that we must know more about the specifics of reactor hazards, safety practices, and insurance coverage. This is the purpose of the first set of public hearings on the question of public liability. We also want to identify other roadblocks, if any, to private development.

Next, in executive session, we will examine the international aspects in order to compare the progress of the United States with that of other countries in this field. Here and in the public hearings which follow we will attempt to assess what would be the effect in the position of the United States in the world if we ceased to be the leading nation in the peaceful uses of atomic energy.

Finally, we will consider the Gore bill and other proposals for accelerating the program through Government construction of additional power reactors. Here we will want to determine the status of private atomic energy projects, and consider what additional efforts, if any, are required.

The McKinney panel, in its report, stated that if private industry does not or cannot assume the full risks and burdens of the nuclear power development, then the Government must do the job. Thus if Congress is expected to grant concessions to private industry, in addition to insurance or indemnity coverage in order to back up a lagging program, it may well conclude that more direct Government sponsorship and initiative is required to get the show on the road. This would not necessarily mean complete Government financing or construction of atomic powerplants. It could mean, for example, a cooperative arrangement such as the Shippingport project, where the AEC through its contractor is constructing the reactor and the Duquesne Power Co. is responsible for constructing the generating facilities and operating the entire plant.

After these hearings, I hope that our committee will be able to report to the Congress whether or not we believe that greater Government participation, in addition to that of private industry, is now required.

At the end of these hearings we should be able to report to the Congress and to tell you, Mr. President, what if anything needs to be done to assure necessary atomic progress in the United States in order to maintain world leadership and to develop and conserve our own natural resources. The Congress will then be in a position to take such steps as it considers necessary in order to achieve these objectives.

Chairman ANDERSON. In my opinion there are three basic questions with which the hearings should be concerned:

(1) What is the true nature of world leadership in the field of atomic power, and of America's role in it? Does it consist primarily in developing the technology to provide the basis for eventual construction of prototype and commercial plants, or does it consist in building such plants on an accelerated scale to obtain experience and achieve kilowatt production goals?

(2) Is it important that we maintain our world leadership in civilian atomic development? Does America's role with the peacetime atom have a psychological significance in our competition with the Soviets and our friends in the United Kingdom and Europe far greater than merely to achieve economic atomic power at a normal

industrial rate? Will the progress of our own domestic atomic energy industry depend to a considerable extent on the foreign market for American atomic powerplants and their components? I think the answer to these questions is "Yes."

(3) If so, the third basic question is how do we maintain this leadership? Through an independent effort by private industry? Through a private demonstration program supported in part by the Government? Through construction of Government demonstration plants? Or do we do it by some combination of the three?

The nub of the problem we are concerned with today, it seems to me, is the pace of atomic development. Who is determining that pace, and who should be determining it? Whose task is it to keep the program moving?

As you know, it has been alleged that the pace of our development is lagging. Attention has been drawn to the fact that we will have only one prototype in operation in this country until at least 1960, and possibly later. No commercial types have been planned. England and Russia, on the other hand are going full steam ahead with the construction and operation of full scale central station atomic powerplants.

It seems to me that the real policy issue involved—the pace of our atomic development—was set forth clearly in the Commission's statement dated May 18, 1956, of its position on S. 2725, the Gore bill. On page 2, the AEC stated it succinctly as follows:

> The Commission takes the view that while it must take the lead and carry most of the burden of developing nuclear power reactor technology, industry should take the initiative and assume the major responsibility for full-scale prototype reactors.

Mind you, the Commission is talking about uneconomical demonstration powerplants, still in the prototype stage. It raises a fundamental question of whether AEC has abdicated some of its responsibilities to private industry. Can we expect these uncoordinated groups still in a developmental stage to provide the direction and accomplishment necessary to maintain our world leadership?

In addition to these basic questions, there are a number of other questions which should be appropriately explored in these hearings. Among them are the following:

(1) What are the technical roadblocks in the civilian atomic energy program?

(2) Does it appear that the private atomic groups will achieve their schedules for prototype development set for 1960–62?

(3) If the Congress authorized 6 or even 3 reactors for construction, which types should be built and where?

I believe we should be particularly interested in atomic powerplants which would serve the emerging needs of the friendly countries of the West, as well as help in achieving economic atomic power in this country.

Undoubtedly many other relevant questions will be explored.

We will begin our hearings with Senator Gore explaining his bill and the reasons for it. Following Senator Gore the Commission will make its presentation.

Senator Gore.

Representative HOLIFIELD. Will the gentleman yield for just a moment? Mr. Chairman, I would like to say that as one of the coau-

thors of this bill, I will be unable to attend the hearings because of a schedule of hearings which the subcommittee of which I am chairman will be holding outside the city of Washington. The fact that I am not here is in no wise to be taken as an indication that I am not interested in the bill and not supporting it fully.

It is just a matter of accommodating myself to a former schedule of engagements which makes it impossible for me to attend the hearing.

Thank you, Senator Gore.

Chairman ANDERSON. Senator Gore, will you proceed, please?

STATEMENT OF HON. ALBERT GORE, A UNITED STATES SENATOR FROM THE STATE OF TENNESSEE

Senator GORE. Mr. Chairman and gentlemen of the committee, I appreciate the courtesy accorded me and the privilege which is mine. I appear before the committee this morning to express my views on and to request immediate and forthright action by the committee and by the Congress on a matter of vital concern to all Americans and to the free world. The objective in which we are all interested may be simply stated—the development of peaceful uses of atomic energy and the dissemination of practices and procedures involved to peoples throughout the world as rapidly as possible.

My appearance before the committee is based upon the premise that as a matter of urgent national policy we must marshal our resources to assure that the United States retains leadership in the field of atomic power. There are a number of reasons why this is so.

In the first place, it is manifestly in our interest to develop economically feasible power reactors from the standpoint of our own domestic economy, I am aware of the fact that our country is blessed with comparatively abundant supplies of conventional fuels. Our supplies, however, are not inexhaustible and there are regions of our great country which, even now, are known as high-cost power areas. When we contemplate expected future demands for power as set forth in the McKinney Panel report, it is obvious we can use atomic power to our advantage, not as a replacement of, but as a supplement to that generated by other fuels.

Perhaps of greater significance to our own economy in terms of urgency of the problem is the question of foreign markets for reactors. To that country first to develop reactors will go orders for reactors and other items associated with their operation.

To quote the words of Dr. Libby, a member of the Atomic Energy Commission, in an address before the American Power Conference on March 21 of this year:

> Loss of the foreign market to the Soviets would be a catastrophe to the free world.

I agree with Dr. Libby's conclusions.

The point can be taken one step further. It is obvious that loss of this race to the Soviets would be catastrophic for many reasons, but from a purley commercial standpoint, loss of the race to Great Britain, France, or some other free nation would have a not dissimilar economic impact upon those in this country interested in supplying the markets of the world.

The stakes in this race are high. They cannot be measured merely in terms of our own selfish economic interest. Our country is under a moral compulsion to gain and retain leadership in development and application of atomic energy for peacetime use.

We have spent vast sums in our program to harness the atom. In the eyes of the world, Mr. Chairman, we have placed major emphasis upon atomic destruction, as indeed we have. We are the first and only nation to unleash the atom for destruction. We have a clear moral responsibility to be the first to make this marvelous new source of energy available to improve the lot of mankind.

Here is the opportunity for us to dispel the Soviet propaganda that we are a Nation of warmongers. We must not lose the opportunity if we expect to lead successfully the free nations of the world in the continuing struggle against world communism.

We have entered this race, if I may use that term, because we could not do otherwise. It is a race in which anything other than victory is a disastrous defeat. Nothing less than a full effort offers reasonable assurance of victory. I believe the American people would not only support, but would demand a full effort if they are given all the facts.

This brings me to the question of our relative position in the atomic power race. It is difficult to make any exact comparison between our progress and that of other countries, particularly so because of the secrecy surrounding that which is being done, or that which is not being done.

But enough data are available to justify the most serious concern on our part. It must be kept in mind that we began our program in an advantageous position, as compared with that of our competitors, or at least we were led to believe so.

If we are now holding our own, it means that, relatively, we have lost ground. If, as Commissioner Murray has stated, we are: "Running with the field when we should be well ahead," such a situation calls for immediate reappraisal of our program.

In my view, there is substantial evidence to indicate that we may already be running far behind, rather than "with the field." As I have said, it is difficult to make exact comparisons after taking into account the different circumstances which exist within different nations.

For example, it is said that the fact that Britain may be proceeding faster than we in construction of reactors can be explained by Great Britain's compelling need for additional power. It is no doubt true that other nations are faced with greater economic compulsion than are we in this connection, but this fact should cause us to redouble our own efforts. To advance such arguments in justification of our own lack of reactor construction is merely to alibi the situation.

What are the facts with respect to our own program for development of full-scale power reactors? They can be fairly summarized, I believe, as follows:

We now have under construction at Shippingport, Pa., a pressurized water reactor which is expected to produce around 60,000 kilowatts of electricity. This plant is scheduled for completion in 1957. The reactor is being financed almost completely by the Government under the authority of the Atomic Energy Act of 1946.

No actual construction whatsoever has been initiated under the reactor development program authorized by the act of 1954. The Commission continues to negotiate with five groups which are said to have submitted more or less firm proposals for the construction of reactors.

Even if the dates projected for completion of these projects are met, we would have by 1960, including the capacity of the Shippingport reactor, a total of only 689,000 kilowatts of capacity in being.

Unfortunately there is a very large "if" involved in this modest objective. Without in any way implying bad faith on the part of any of those concerned, I say that we have no assurance that the target dates will be met.

With respect to two of the projects, the Commission has proceeded to issue construction permits. The issuance of such permits, however, imposes no obligation whatsoever upon the recipient. Perhaps this is as it should be. The program remains entirely voluntary on the part of the private companies participating. That, too, is as it should be. There is nothing in the nature of a contractual agreement. In the event the private companies concerned, for one reason or another, find themselves unable to proceed according to plans, the net result will be that we have lost just that much additional time.

The full-scale reactors included in this program involve four different types of reactors: The pressurized water, the boiling water, the sodium graphite, and the fast breeder.

There is no program for construction of a full-scale reactor using the homogenous process, the fifth of the types of reactors which, along with the four previously named, I understand to have received the greatest emphasis in our experimental program thus far. The Commission includes in its charts and presentations a proposal of the Pennsylvania Power & Light group to construct a homogenous reactor which is scheduled for completion in 1962, but no definite proposal whatsoever has been received. It is my understanding that this group has stated that it will not even reach a firm decision as to whether or not to proceed prior to 1958.

We do not have programed large-scale reactors which would utilize the technology developed by the Hanford graphite reactor or the Savannah River heavy water reactors. Nor are we following up the gas-cooled approach which was used in the original reactor design in 1942 and upon which the British are at present relying heavily.

When our program is recapitulated, then, we are able to project a total of 689,000 kilowatts of power using 4 different approaches by the year 1960, with no real assurance that even this much will be accomplished.

The British will put their first large atomic powerplant into operation, according to announced plans, in the fall of this year. It appears they will be a year ahead of us in this respect. It is true that this particular reactor, together with another similar one under construction, is a dual-purpose reactor designed for both the production of power and the production of plutonium; but the fact that such reactors, Mr. Chairman, are also used to produce plutonium does not materially detract from their usefulness as power producers.

In addition to these two under construction, the British in June of last year announced the proposed construction of 6 additional dual-

purpose reactors similar to the 2 already under construction, but the British are not confining their effort to dual-purpose reactors.

In February of last year they announced in a white paper a 10-year program for the construction of atomic reactors designed for the production of power. During the ensuing decade, the British propose to construct 16 such reactors with a total capacity of some 1.5 to 2 million kilowatts.

It is one thing, Mr. Chairman, for our British friends to outstrip us in reactor construction, as indeed they appear likely to do. It is quite another matter for the Soviet Union to outstrip both us and the British.

At the Geneva Conference last summer, the Russians presented a very thorough scientific paper covering the details of a 5,000-kilowatt atomic reactor which they said had been in operation since June of 1954. Members of the committee have had an opportunity to see a well-done moving picture of this reactor in operation, accompanied by detailed commentary expressed in the English language. I saw it in the committee room yesterday morning. Others have seen it before. I am advised that this film has been shown virtually around the world in appropriate languages. It has not been publicly released in the United States. It was about 1 year later, just about the time of the conference, that we placed in operation our first comparable reactor which had a capacity of only 2000 kilowatts.

At a recent Communist Party conference, the Russians announced a 5-year reactor construction program. They proposed the construction during the 5-year period of 10 full-scale power reactors, having a total capacity of from 2 to 2.5 million kilowatts, with each reactor to be of a different type, and with construction of each to be started before small-scale development is completed.

Last month in a remarkable address before the British atomic scientists, Mr. I. V. Kurchatov, Soviet academician, spelled out in considerable detail Russia's plan for this 5-year program. In brief, Mr. Chairman, this plan calls for the construction of between 2,400,000 and 2,500,000 kilowatts of capacity during the years 1956 to 1960, with considerable capacity coming into operation as early as 1958.

I have a copy of that speech here, and I asked the staff to prepare a table showing the contents of this speech in tabular form, which I have attached to the back of my statement.

Chairman ANDERSON. Is that exhibit No. 1?

Senator GORE. Yes, as an exhibit. I attach as an exhibit to my testimony a summary of the plan presented by Mr. Kurchatov which indicates the type of power stations contemplated and the types of atomic reactors to be used.

I wish to emphasize, Mr. Chairman, that the source of these tables is this speech and other unclassified sources. If you would like the speech itself to be included in the record, that is subject to your decision.

This construction program announced by the Soviets is of a scope that dwarfs the very best anticipated under our own present program. I say in all seriousness that this information with respect to the Soviet program makes mandatory a reexamination of and an acceleration of our efforts.

I make no attempt, Mr. Chairman, at a personal evaluation of the validity of Russian claims as to their progress in this field of their announcement of future accomplishment. I do say that on the basis of past experience, the Soviets have demonstrated a marked ability to accomplish that which they have announced, when the circumstances are such that it is in their national interest to do so.

It is my view that the primary objective of current Russian policy is to surpass the United States in the development of atomic energy for the generation of electric power. Their motivations appear to be fourfold:

(1) The political, propaganda, and prestige advantages of excelling in the peaceful use of the atom.

(2) The value of experience in actual construction and operation of large-scale reactors. Apparently the Russians believe the old adage that one learns by doing.

(3) Economic and industrial advantages, which can be spelled out in great detail.

(4) Plutonium production for weapons purposes.

I am convinced, Mr. Chairman, that these motivations are sufficiently strong to insure an all-out effort on the part of the Russians to accomplish this primary objective. In our planning, we cannot afford to assume that they will not succeed.

From the evidence I have cited I must conclude that we are losing the race for construction of industrial and civilian atomic power reactors.

Some would say that it is not realistic to judge our own relative progress in terms of kilowatt capacity. They say nothing is to be gained by entering the kilowatt race. This is another way of begging the question. We need kilowatt capacity because we need to have reactors in operation. Until we have plants actually in operation, we have only theory.

On January 31, 1955, Admiral Strauss, the Chairman of the Atomic Energy Commission in testimony before this committee, stated as follows:

> The Commission recognizes that the greatest advances in reactor technology will come from the actual construction and operation of large-scale reactors on a commercial basis. There is no effective substitute for such practical experience.

I agree thoroughly with that statement. Until plants are built, we have only estimates of cost of construction. Right now, we do not have even reliable estimates of cost of operation. Mr. Louis H. Roddis, Deputy Director of the Commission's Division of Reactor Development, in remarks before the American Public Power Association last month, where I also had the privilege of making a speech, stated that the Shippingport reactor now under construction—

> will provide valuable economic and operation information obtainable only from a full-scale installation.

In short, Mr. Chairman, we must construct reactors if we are to perfect them. Reactors on the drawing board will not win this race any more than airplanes or tanks on the drawing board will win a war.

Furthermore, in the eyes of the world, we are in an atomic power race, whether we like it or not. Nothing is to be gained by disparaging that fact. That country which first produces substantial quantities of atomic power for actual commercial use will, in the minds of most, have

won the race. Our statement that we are working on something that may be better will fall on quizzical, if not deaf, ears.

I am also aware of what may be termed the "wait and see" argument. There are those who are not completely satisfied with our present rate of progress, but who feel that we should wait an additional period of time before deciding a different approach is necessary. I respect the views of those who take this position, but I differ with them sharply. I do not believe we can afford to wait. Now is the time for decision and action.

I have already pointed out that under our present program there is no assurance that the target dates now specified for completion of reactors under consideration will be met. For the purpose of argument, however, I am willing to assume they will.

Even if they are met, however, we will still be considerably short of construction schedules set by Great Britain and the objectives publicly announced by the Soviet Union. In my view, it would be folly to wait until we know whether private companies will complete their present plans, if, when that optimum development occurs, it will have still left us in second or third place.

What are our plans for the future? Will the Atomic Energy Commission ask for a third round of proposals? If so, what will be the response? I do not know, nor, I suppose, does anyone else. I say we cannot afford to wait until 1960 or 1962 to appraise the results of the present program. By then, we will have decidedly lost the race. Even at best, it falls far short of goals required by our national interests.

The task ahead is not a simple one. There are many technical obstacles to be overcome. I have no doubt that they can be overcome. The question before this committee is how can they be overcome in the shortest possible time.

With the passage of the Atomic Energy Act of 1954, our atomic power program was relegated to the position of a secondary effort. I will not belabor the committee with a review of the debate which accompanied the passage of that act.

As the committee members will recall, I opposed many of its features. I felt then as I feel now, that Government should continue to lead the way in developing peacetime uses of the atom, just as it had developed the atom for wartime uses. I felt then that it would be unwise to rely exclusively upon a program for the development of reactors by private enterprise under a system of licenses to be administered by the Atomic Energy Commission.

I felt then that the inclusion of a "No subsidy" provision in the law constituted an excessively optimistic conclusion even on the part of those who were most eloquent in their predictions as to the capability and eagerness of private enterprise to get on with the job.

I want to make it emphatically clear, Mr. Chairman, that I am not critical of private enterprise for what I consider to be a slow rate of progress. I think the program has advanced as fast as could be reasonably expected under the philosophy and terms of the 1954 act. The fact remains, however, that after 2 years of operation under the law, no reactors have been built, nor has any actual construction even started.

I applaud the fact that industry today apparently stands ready to commit from $250 million to $300 million toward construction of re-

actors during the next 4 or 5 years. This is a sizable sum of money. It has not, however, yet been spent or even legally committed.

I say in passing that though this is a substantial sum of money, many of our leading corporations spend more than this amount in a single year for expansion and improvement of their ordinary facilities. I doubt that this sum can be considered an adequate effort on the part of our entire country as applied to a task so huge and in which the stakes are so high.

The fact that we today have under consideration a number of special-purpose bills designed to remove any obstacles indicates that there are roadblocks holding up even our present inadequate program. We are, in effect, now put on notice, 2 years after passage of the law, that industry cannot proceed under the act of 1954.

Chairman ANDERSON. Before you go on and merely because it will come up later, in the close of the previous paragraph, you said, "Nor has any actual construction even been started." Do you want to comment on the fact that there is a small plant being started in Virginia, which will have a relationship to Consolidated Edison's plant in New York, and there is a plant being built out in California, probably 7,500-kilowatt plant, which will have a relationship to the Commonwealth Edison plant in Chicago?

We might come back some day and say, "Is that not construction."

Senator GORE. I am aware of that project. I was referring to large-scale reactors. As I understand it, those are supplementary or supporting facilities for research, and for fuel treatment and so on. I was referring in this statement to large-scale reactors for the production of industrial power.

Now, I am perfectly willing to make any reasonable concession to private enterprise to facilitate its participation in the atomic power program. Nothing would please me more than for private enterprise to accept the invitation extended by Dr. Libby in his address of March 21 when he told his audience: "The ball is in your hands."

I am willing to help private enterprise act upon this invitation. However, Mr. Chairman, under present circumstances, the Russians are running with our ball.

Not by way of criticism, but by way of analysis, let us for a moment examine the private enterprise features of the present program. Despite the "no subsidy" features of the law, most of those now interested frankly admit they cannot proceed without direct Government assistance. All would have the Government assume at least part of the hazard risk. Some ask for specific tax treatment as an inducement. Others want exemptions from certain regulatory features of existing law. Some insist upon all three.

There is yet another aspect of the matter to which I would like to call the committee's attention. Most of those now offering to participate in a reactor construction program are public utilities. As such, their expenditures in the program will be included in their rate base and recovered by them from their consumers in the form of rates, despite the fact that the power produced may be considerably higher than that now available from conventional fuels.

In other words, Mr. Chairman, the consumers located in the service areas of the few companies participating in the program will shoulder the financial burden of the effort insofar as funds are advanced by

the sponsoring companies. This is a rather unusual situation. By and large, under our private enterprise system, the development of new processes and new techniques is undertaken by and at the expense of equipment suppliers. These are the people who receive the benefits of new developments in the form of sales of the equipment in question. We have, beyond a doubt, the world's most capable firms of this type. Yet they are not sponsoring the development of demonstration reactors. I mention this situation merely as another illustration of the fact that the program ahead is not one which will or can be advanced along traditional lines of private enterprise development.

Mr. Chairman, I hope it is obvious that I consider our present program inadequate in the light of conditions we face. I hope it is clear that I do not wish to exclude private enterprise from the program, but that I wish to expand participation by private enterprise. We cannot, however, ignore the fact that other countries are approaching the task with a sense of urgency which is not reflected in our own program.

We should no longer be under any illusions about the capability of the Soviet Union. We know that the Soviets will use every resource at their command to accomplish any objective they consider really important.

The British and others are likewise throwing the full resources of government behind their program. We must use the full resources of both Government and industry if we expect to keep the pace. That is what I propose be done.

Last July, I introduced a bill, S. 2725, which is now before this committee. I have no particular pride of authorship in the language of the bill. I want to emphasize that the philosophy behind the bill is the enactment of a program under which the full resources of Government would be placed on the line. The bill would not in any way impede the present program; it will supplement it.

Some may ask, "How can the Government build reactors any faster than private enterprise can build them?" It is true that we have only a given number of scientists and technicians. It is true that the same or similar technical and engineering firms would do the actual construction in either event. The answer, however, is that the Government can do the job faster.

The Government, representing the whole people, can assume a greater economic risk than can any one company or any group of companies. The Government can marshal all available resources. The Government is not faced with many of the obstacles which retard progress by private enterprise.

There are many examples of expeditious action by our Government which could be cited. The control of the atomic reaction itself is a prime example. I refer also to the time schedule for the construction of the Savannah River plant of the Atomic Energy Commission. Here, a new concept of reactor design was agreed upon, tests run, design drawings made, prototypes constructed and tested, procurement of components initiated, construction undertaken and completed in from 3½ to 4 years. Such examples illustrate what can be done if we will but make up our minds that it needs to be done, and that it must be done in the national interest.

This is not and must not be considered as a controversy revolving around the issue of public power versus private power. It is simply a matter of getting the job done as quickly as possible.

I do not assert that there is any program which will absolutely guarantee our ultimate victory. The Chairman of the Atomic Energy Commission has stated that there is no way we can insure against someone else inventing something before we do. I agree; but we must use every resource at our command to see that they do not outstrip us in this vital field. If we follow such a course there will be no basis for recrimination if we fail.

I recognize the somewhat unique position which I occupy in presenting this matter to a committee of which I am a member. I appreciate the privilege you have accorded me. I say in all frankness that I am convinced that it is imperative that this committee and the Congress take action at this session to accelerate our efforts.

On the other hand, I say in all sincerity that I do not have a closed mind on the subject of what should be done. I have suggested a program, but I will listen eagerly to other suggestions that may be offered during the course of these hearings.

I hope the members of this committee share my concern about the overall problem. If so, I am confident we shall be able to reach agreement upon a program which will approach the question of winning the peace with the same vigor as that used to win the wars.

(The tabulation presented by Senator Gore follows:)

EXHIBIT NO. 1 TO STATEMENT OF SENATOR ALBERT GORE, JOINT COMMITTEE ON ATOMIC ENERGY, MAY 23, 1956

Outline of U. S. S. R. atomic power program for 1956–60

	Electric power output in kilowatt-hours
A. Large atomic power stations:	
Developmental: Capacity, 400,000–600,000 electrical kilowatts per station (200,000 electrical kilowatts per reactor).	
Dual-purpose stations	800,000–1,400,000
Plutonium production with some power production.	
Low-cost fuel:	
Natural uranium	
U–235 enriched seed-core	
Optimized power stations	1,400,000–800,000
Power production with some plutonium production.	
High-cost fuel.	
Enriched uranium.	
B. Pilot-plant stations	200,000–300,000
Experimental: Capacity, 50,000–70,000 electrical kilowatts per station (one reactor per station).	
Total	2,400,000–2,500,000

Types of Soviet atomic-power reactors

	Fuel
Large power reactors:	
1. Carbon dioxide cooled, heavy water moderated	Natural uranium
2. Water cooled, water moderated	Enriched uranium
3. Water cooled, graphite moderated	Enriched uranium
Pilot-plant reactors:	
4. Boiling water	Enriched uranium
5. Heavy water-thorium homogeneous breeder	U–233
6. Sodium cooled, graphite moderated	Enriched uranium
7. Sodium cooled, fast breeder	Plutonium

Chairman ANDERSON. Thank you, Senator Gore. I see that in the statement you have attached here, you have the different types of atomic power stations that are going to be built. You have not attempted to give an estimate as to how much capacity they might develop year by year, except to say that the total at the end of the period, 1960, is supposed to reach about 2,400,000, or 2,500,000 kilowatts. Would it be fair to assume that it is going to grow progressively faster and that it will probably be less in 1958 or 1959 and a little more toward the end?

Senator GORE. In reply to your question, Mr. Chairman, I will read a sentence from the speech of Mr. Kurchatov. "According to this program, the atomic power stations will be put into operation beginning with the end of 1958. Some of them will start operations in 1959, and in 1960."

So apparently, if his speech is authentic, it is a program of progressive development.

Chairman ANDERSON. Are there any questions?

Representative HOLIFIELD. Mr. Chairman, I just want to aline myself with the statement of the gentleman from Tennessee, Mr. Gore. I want to say in the consideration of the 1954 act that I made quite clear in a dissenting report which Mr. Price and I both signed, that I considered the timeliness of throwing open the atomic energy development to private industry was in error. I maintained at that time that the quickest progress in the development of the technology of the art would be in a full-scale crash effort on the part of the Government, and that any attempt to transfer the burden to private industry at that particular time would be abortive, and would not accomplish the results which any of us wanted to accomplish.

I think the events of the last 2 years have proven that to be a fact. I think that there has been a confusion in the industry. There has been a pirating of skilled technicians and engineers, and physicists, from the Government facilities into various private industries in an attempt to build up organizations within these industries. There has been a holding back on the part of industries, private industry, in making investments for the very good reason that they could not make them on the basis of a profitable investment. I have no criticism, but I am merely acknowledging or stating that that is the fact. Private industry, and boards of directors of corporations, have obligations to their stockholders to invest their money in such a way as to return profits to their stockholders, and this is as it should be. But I maintained at that time that it was too early in the art of the industry for this to be a profitmaking economic type of operation, and I am speaking now of the major processes and not of the building of small testing devices and other small gadgets which are used in the trade.

I take the position that if the Government had gone ahead with the full-scale crash effort for the development of the electrical power reactors that we would have been in a better position today, a further advanced position today, than we are, and this technology which would have been acquired in these fields could have been passed on to private industry much quicker than they can originate and develop by themselves.

For this and many other reasons which time would not permit me to state at this time, I take the same position that the Senator from Tennessee takes, that if we are going to obtain the lead in the development of electrical kilowatts on an economic basis in the world, it must be through a crash effort of the Government much as we used in the development of weapons.

Whether this is as important from a propaganda standpoint as the Senator from Tennessee outlines in his program, as the Commission has said repeatedly, and some of the members believe, I am not so sure that I attach the degree of importance to the propaganda elements involved. I agree with the Commission on the fact that the development of non-economic reactors and huge numbers of kilowatts is not the answer. I think that the development of economic reactors or near economic competitive reactors is the one and only way that we can obtain prestige in the world. I believe that the building of a reactor such as the Shippingport reactor, which will be uneconomic, and which will be subsidized by the Government, will be something that will give us experience but I do not believe that it will give us prestige. I do not believe it can compete with conventional fuels, nor could I see any indication that we will be able to compete for several years.

That is why I think that the Government should make the effort because it can make an effort not depending upon profits to stockholders which private industry cannot make.

With that statement and with the privilege of extending it for the record, Mr. Chairman, I will ask to be excused. I have to catch a plane in about 30 minutes to California.

Senator PASTORE. First of all, Mr. Chairman, I want to compliment and congratulate my distinguished colleague for his very illuminating remarks on this very important subject. I quite agree with him in the predicate that he has outlined that this job needs to be done. Our question is, of course, how can it be done most effectively, and work out all of the elements either surrounding the development or the retardation of this program that all of us desire to see blossom out in full fruition.

Now, I go along with him that if we are outdistanced by Russia in this race, it would be catastrophic. If we are outdistanced either by the United Kingdom or France, there would be a tremendous economic tragedy to the commerce and the international commerce of this great Nation of ours.

But yet I do not see anything in the law of 1954 that would either circumscribe or prevent the procedures that he has outlined. The thing that concerns me is that oftentimes those who have been reluctant to see some kind of governmental subsidy of this program have been the most vociferous in terms of letting the Government do it entirely itself. That, to me, seems to be sort of an inconsistency that I have never been able to reconcile in my own mind.

Now, I go along with the distinguished Senator from Tennessee when he says that the Russians have made tremendous progress. On my return from the Pacific site, I stopped at Livermore and I stopped at Berkeley and I had a little conference with some of our great scientists who were at that fine institution of learning, where I learned that Louis Alvarez, Dr. Louis Alvarez, is now visiting Moscow. I was very, very much interested and intrigued when I read in the paper the

other day that he made the statement—because there I saw a cyclotron at Berkeley, and a betatron—and he said that a cyclotron that is being built in Moscow actually bowled over the visitors, that is, the American scientists who are visiting Moscow.

Now, there is no question about it that the Russians are making tremendous progress. There is no question at all about it that industry has come before our committee and has set forth in no alarming terms, but I think in judicious and calm and patient terms, in fact, that there are certain obstacles that need to be rectified if they are to get into this program wholeheartedly.

I agree with the distinguished Senator that two or three hundred million dollars is not quite enough. I quite agree with him that private industry cannot embark upon this venture full-scale; if that is so, then the Government needs to do the job because if we do not, the tragedies have been pointed out as to what will happen in case we do not.

But I am convinced that there has been somewhat of a lack of appreciation and understanding on the part of the American Congress as to the difficulties of private industry in this whole matter. It is true that we are conducting now hearings that have to do with the insurance problem. But I daresay, we will recess this Congress and that problem will not be met. There is a specific problem of certain industrial concerns, and the distinguished Senator has brought it out in his remarks, that while most of this field is now being engaged by the public-utility companies, we are looking for the chemical and industrial concerns, those suppliers of the equipment, as the distinguished Senator brought out. Now, in that particular realm, we have the problem of whether or not they should be entitled to a statutory exemption under the Public Utility Holding Company Act of 1934, which raises another problem. Now, all of those are heavy problems that have to be met in a clear-cut judicious fashion. I dare repeat again that I doubt very much that this Congress will do a great deal about that problem before the adjournment of this session.

So, insofar as this hesitation, or reluctance or retardation is concerned, I think, myself, it is a little bit the fault of all of us. The program that the Senator has outlined is going to be a very, very specific one. I think that the cost should not serve as a deterrent if the job needs to be done. But I should like to ask the Senator in what terms of money is he thinking, either for authorization or appropriation for the Government to embark upon this program. That is my first question.

Senator GORE. I had reached no final determination as to what amounts would be necessary. I had thought that before the committee acted on that subject it would have the benefit of the advice and recommendations of the Commission. In round terms, I had thought of the program in the terms of $500 million, or more. If it is $1 billion, I would still be as vigorously in support of the program as I am now. That being my answer, may I express the hope that this Congress will act on the insurance problem and will remove some of the roadblocks.

Now, I had originally thought that I would insist on tying the two together. I would hope that the additional concessions that are necessary for private enterprise to enter this field and the authorization and direction for the Atomic Energy Commission to go forward vigorously with such a program as I have suggested could be tied together.

But I will support reasonable concessions to bring private enterprise into this field irrespective of what action the committee and the Congress take on my proposal. I think it is important.

Chairman ANDERSON. Can I stop you there to express my belief that the Congress will take some action on this insurance matter, and to call attention to the fact that no representative of any private industry so far as I know ever asked for any relief on that question until about 60 or 90 days ago. Then we decided it would be pursued, as we have pursued it, by hearings. Private industry was not the one raising the question, but the committee, itself, was raising it. I think that they are going to need some help, but they presented their proposals on April 1, or thereabouts, and not one of them said that the insurance matter was a problem at all. If there is any fault, the people that are going to be hurt have the responsibility to come in and say, "We are about to be hurt."

Secondly, as to the Holding Company Act, we had testimony in the hearings last week, from Consolidated in New York that the Holding Company Act presented no problem to them whatsoever. We had testimony from Commonwealth Edison that the Holding Company Act presented no problem to them. It is only Detroit Edison which has difficulty there. They have set up a cunning arrangement that I admit is taxwise very ingenious. But if you do not start scheming you do not get caught. I will not say they have been cute in any improper relationship, but they ran themselves up against the Holding Company Act by dragging in all sorts of organizations they had nothing whatsoever to do with the generation of electric current. I admit that is a hard problem to solve.

Senator PASTORE. I was merely citing this. I would rather be constructive and be wrong than be critical and be right.

We are reaching a point here where it is no longer a matter of whether we are going to be critical and whose fault it is. I think that we have a definite job to do, and we are all in this boat. If anyone of us gets out of balance, this boat is going to sink.

Now, on the question of the Consolidated Edison Co., of course, fundamentally, they do not come under the Public Utility Holding Company Act because they are going to own this facility. I am only talking about a half a dozen small industrial concerns that want to get together on a research and development project. In that case they have got to come under the act.

Now, the Consolidated Edison does not have that problem, because after all they are going to own these facilities. But there, again, I do not want to get into that phase of it. I am just stating here predicates and prefaces more than I am stating a criticism or a pattern of criticism.

But the point I mean to make, and I would like to have the observations of the distinguished Senator from Tennessee, is this: The same people who have expressed a desire to get into this field on a private initiative basis, on a pattern of free enterprise, are the identical people that we must go to if the Government decides to invest this money.

Now, if that be the case, if all of those that the Government of the United States must call upon to build these reactors are the same people who today have expressed an interest to get into this field

by using their own money, and there are no more and no less, there they are. We know who they are, and we know what their aspirations are, and we know what their goals are, and we knows what their objectives are. Now, if they are the same people, and speed is the thing that we want, does not the distinguished Senator feel that while it is advisable to have a cooperation and a partnership between the Government and private industry, there are many things that we can do along the lines of injecting a strong impetus in this whole program by speedily meeting these problems that have been raised by private industry, regardless of whether they have been called to our attention only in the past 90 days?

Senator GORE. I agree with the premise of the Senator.

Senator PASTORE. Has the Senator any knowledge that there are other people who will get into this program only if the Government puts up the money rather than those people who are now available for that purpose and who have already expressed a desire to put up their own money?

Senator GORE. I think that there are, Senator. I do not think that we can assume that the companies, that the people, that the industrial know-how in this field, are confined to the few companies who have offered to participate in this program.

I think the scope is much broader than that. That is both as to individuals and as to capital structure and as to industrial capacity.

Senator PASTORE. I am not being critical of the Senator because I think the Senator may be right, but I am directing that question to you hoping that the members of the Commission are attentive to the question that I have just asked, because I think that question needs to be explored. If there are any concerns in this country who are willing to get into this field and cannot do it only because they do not have the right connections, and only because they do not have the right associations or because they do not have the money and know-how, then I think it becomes incumbent upon the Government to see that they are encouraged. I go along with the Senator in that respect, and I do hope that the Chairman of the Commission will explore that situation when he gets about to testify.

Senator GORE. Senator Pastore, there may be many reasons why private enterprise does not want—or a private company does not want to come into the present program. After all, the five companies that have offered to come into it unanimously say that they cannot go forward under the present program. There are many other reasons why.

Now, I, for one, have never been critical, not once have I been critical of a private concern having reluctance to enter this program.

After all, as I said to you on the floor of the Senate one day, were I a member of a board of directors of a corporation, I would hesitate, I think, to vote to spend 50 or 100 million dollars of stockholders' funds on a venture that may not be profitable, that, indeed, might be outmoded before completed.

Senator PASTORE. That is true, and this is a thing that bothers me and concerns me. Mr. Cisler has testified before our committee that his power group, his reactor power group, represents 40 percent of the entire electrical output of this country. I am surprised to see that at this stage where you have already admitted that there is no

profit to be foreseen in this thing maybe for 15 or 20 years, we have more people crying from the rooftops about monopoly than we have people talking about the encouragement to get into this.

Now, I think, myself, that this monopolistic idea is being distorted a little bit in this whole field. There is no monopoly in this research field. As a matter of fact, it is just as new as a newborn babe. We have a long ways to go before we can manufacture this current through the use of nuclear power to produce electric power. We have so long a way to go that I think that anyone who talks about monopoly at this stage is doing a crybaby act of large proportions.

Senator GORE. Mr. Chairman, I would like to suggest to the Senator and to the committee that the industrial know-how and the technology involved in atomic reactors is not necessarily the kind of technology that a public utility has. The generation of electricity by steam plants or hydroelectric dam is not even a third cousin to the construction of a reactor.

Senator PASTORE. I realize that.

Senator GORE. There are some concerns, and, in fact, the vast number of concerns in the United States that have superior knowledge in this field—they are not public utilities at all. It is that large reservoir that I believe the Government could depend upon, and could draw upon, and could bring to bear upon this program by Government initiative, itself.

Senator PASTORE. And those people have appeared before our committee and said that if they have to subscribe to the Public Utility Holding Company Act of 1934, they will shy away from this research.

Chairman ANDERSON. Who?

Senator PASTORE. There were quite a number of them that appeared before our committee, and I cannot give you the names, but I can submit a memorandum.

Chairman ANDERSON. The Yankee network is cleared, and they have a Government exemption, and it has no problem at all. Consolidated Edison has no problem at all.

Senator PASTORE. They come under the act. The mere fact that you get an exemption does not remove you from the jurisdiction of the SEC. These boiler works and these industrial firms who are not under that jurisdiction do not want to come under that jurisdiction, exemption or no exemption.

Chairman ANDERSON. They do not have to come under it.

Senator PASTORE. They do. You have to apply, and the minute you apply you come under the jurisdiction. That is our problem and that is the problem that we have to meet and we have to meet it in a judicious fashion. These companies do not come under the Public Utility Holding Company Act because they are not in the public utility business. They manufacture boilers, and they are industrial companies. Now they say, "The minute we get into this partnership, we have to come under the act. We do not want to do that and if we have to do that, we would just as soon stay out of it."

Now, what encouragement do you give them? Do you talk to them about monopoly or do you look at this realistically in the face of what is going on in Russia and what is going on in the United Kingdom and what is going on in France and what are we, as the Congress of the United States, going to do about this?

Chairman ANDERSON. May I just suggest that primarily you reduce it back to the people who have made applications. You find out, No. 1, Consolidated Edison has no problem. When it buys something from Babcock and Wilcox, which it is now doing, it does not ask Babcock and Wilcox to be a partner.

Senator PASTORE. Because they have the money.

Chairman ANDERSON. Others have money.

Senator PASTORE. He is talking about the small firms that cannot do this job alone and have to get in with other people and need encouragement.

Chairman ANDERSON. May I come next to the Yankee group. The Yankee group has people in it that have small amounts of money, and yet they were able to get along very satisfactorily because they made their application and they got their administrative exemption.

As to the two public groups, as you might call them, the Nebraska rural group, Consumers' Power District, has no problem whatever with it. They have made their application, and they are not worried about public monopoly in any way. The Elk River group up in Minnesota has made its application, and they are not bothered by it.

It is only when you try to set up a partnership between the suppliers and they say that the exemption to the Public Holding Utility Company Act shall not apply only in the research period but shall go on for 1,000 years of generation, that they run into difficulties.

Senator PASTORE. No one is for that.

Chairman ANDERSON. That is what they asked for in the beginning.

Senator PASTORE. All I am saying, Mr. Chairman, and if the distinguished Senator will yield, because I think that I have consumed more time than I am entitled to, is this: This is a weighty problem. It is not easy of solution. We must approach this whole problem with an open mind. Rather than be critical, I think that we have to be understanding and constructive. There are many problems. I do not think that we ought to be suspicious of people who come before our committees to make these presentations. We should not assume that there is an ulterior motive here for these companies to become giants. I think that after all, this Congress is powerful and this Nation is a powerful nation. If the ulterior motives develop later on we can always eliminate them just as we did when we passed the law in 1934.

But rather than being suspicious, I think we ought to be helpful. If this program needs to be done, and it must be done, then I say that we all ought to roll up our sleeves and we all ought to clear our minds of all imaginations and suspicions and get to work and do the job. I agree with the Senator.

Senator GORE. I wish to say that I agree with the Senator thoroughly, that insofar as private enterprise is concerned it must remain on a voluntary basis. I would not support a compulsory program. The fact remains, Mr. Chairman, that if the Congress removes all of the roadblocks, every one, to the complete satisfaction of the companies who have proposed to enter this field, and if each and every plant which is now under discussion is completed on schedule, we will still have lost the race.

What I propose is that we supplement the present program, that we move with vigor, with a sense of urgency.

Senator PASTORE. I agree with that 100 percent.

Senator GORE. Thank you.

Chairman ANDERSON. All I have said is that we have tried every way we could to find out what all of the roadblocks are so that they may be removed, every one of them.

Representative COLE. Mr. Chairman, I do not know as I feel impelled to give any expression with respect to the subject under discussion, but if I were to do so it would be 90 percent repetitious of what the Senator from Rhode Island has already said. I think very much along the same line as he.

I do want to correct the record in a couple of rather minor aspects, however. One is with respect to the time when the question of public liability was a factor and considered by the private companies. That goes back much further than you indicated. I cannot give the chapter or the page, but I do know that it was in the minds of some of the operators when we were considering the original law in 1954. It was not a major item at that time, and it was contemplated that it was something that had to be resolved before the plants were put in operation. It was contemplated that Congress would correct it rather speedily.

I am disappointed to hear Senator Pastore prophesy that it is not going to be cleared at this session of Congress, because nothing is going to be actually done by way of operation of these plants until that question is resolved.

Then the other point, which is rather minor, is this: In Senator Gore's statement he referred to the aggregate kilowattage of the pending applications as 689,000. My memory may be entirely in error and it probably is, but I thought it was something over 700,000.

Chairman ANDERSON. I think we had two sets of figures and one came out about 750,000 and the other about 691,000, and somewhere in there is the proper answer.

Senator GORE. I am acquainted with that figure which Congressman Cole mentioned. That includes the small reactors. I was confining my statement to the large-scale reactors for the production of industrial power.

Representative COLE. With that explanation, that is sufficient.

Senator PASTORE. I did not prophesy that nothing would be done this session. I expressed the apprehension, and I did say that, "I daresay nothing will be done." I hope I am wrong.

However, I have seen the Congress work before.

Senator GORE. As this session grows later and later, that becomes an increasingly safe presumption.

Chairman ANDERSON. I think I would agree completely with what Congressman Cole said about the question arising about insurance, previously.

Representative PRICE. I cannot agree completely with that, because it did not arise at the instigation of the industry. The ones who brought up the question of insurance first in the hearings in 1954 were the members of this committee. It originated in the minds of the committee.

Chairman ANDERSON. Now that it has arisen, we have tried to do something about it, and Consolidated Edison said they are going to go ahead and build their plant and trust to the Congress to get the insurance problem solved before it becomes necessary to put the plant in operation.

I would hope that we might regard that as getting something done this session. That would be a proper time to do it and not wait 3 years for it to be accomplished. I think we will all work toward that goal.

Representative PRICE. Mr. Chairman, I first want to compliment the Senator from Tennessee on a very fine and remarkable statement. I think that he does a great service in presenting this problem not only to the committee, because I think the committee was more or less familiar with it, but to the public.

I did not feel that the Senator was in any way stressing the question of monopoly in the statement. I do not think that he even referred to that. But he was stressing the importance of speed in the atomic power reactor program. He suggested a supplemental program. He was not suggesting that we depart from the industrial participation program which he says needs support, and I believe that that is true.

We must bear in mind that if we do embrace the supplemental program, private industry will do the job also, so that we are not seeking the elimination of private enterprise from this program. But the Senator asks, as I gather from his statement, that we do something about stepping up the program to win the atomic power race.

I happen to be one of those who introduced one of the bills on the insurance program, because it was my desire that every impediment or every obstacle in the way of successful conclusion of successful operation of the industrial participation program be removed. I am sincerely hopeful that the Congress does act on that insurance problem at this session.

I would like to set the record straight on the matter of insurance, and I recall very well that during the hearings on the 1954 act insurance was first raised as a problem to be met in the future by one of our colleagues, Mr. Holifield. He pointed out that that would be one thing that would eventually arise as an obstacle to this program and would have to be resolved. I think it is something that our committee should consider. I see nothing unusual about that, but I am sincerely hopeful that the committee will approve a bill. I know that I have been in contact with the Commission, itself, almost since January of this year on this matter of insurance and I am very happy to see that the Commission has suggested legislation at our public hearing. I am hopeful that every impediment and every obstacle in the way of the industrial participation program be removed. Also, I must give my support to the supplemental program as urged here by the Senator from Tennessee.

Chairman ANDERSON. I think it is only fair to point out that you could not do much with the insurance program until the insurance companies decided whether they were going to be able to do something with it themselves. It was only when the insurance companies came in and said that they believed they could provide coverage up to 50 or 60 million dollars, that it then became possible to say that we need to cover above 50 or 60 million dollars. We were allowing the insurance study group to go ahead steadily and they were making progress, and in fine cooperation with the Atomic Energy Commission.

Representative PRICE. I think that it should be clear in the minds of everyone that private industry has always been an important part of the atomic energy program, even through the days of the Manhat-

tan District, from the inception of the program. Every job done by the Atomic Energy Commission was essentially done by private industry.

Senator GORE. My Chairman, I would like to conclude, if there are no more questions, by saying that I believe the challenge to the national interest is so great that it requires the best efforts of both private industry and Government to maintain America's lead in the atomic power race.

I thank you.

Chairman ANDERSON. Our next witness will be the chairman of the Atomic Energy Commission, Admiral Strauss. May I say, Admiral, we are deeply appreciative of the fact that the presentation of the Atomic Energy Commission got here, not just one day ahead, as the Reorganization Act provides, but 4 or 5 days ahead, so we had a chance to study and work with it. Thank you very much.

Mr. STRAUSS. I made some changes in the syntax in my own statement which I only made this morning.

STATEMENTS OF LEWIS L. STRAUSS, CHAIRMAN; DR. WILLARD F. LIBBY, COMMISSIONER; HAROLD S. VANCE, COMMISSIONER; KENNETH E. FIELDS, GENERAL MANAGER; A. TAMMARO, ASSISTANT GENERAL MANAGER FOR RESEARCH AND DEVELOPMENT; R. E. HOLLINGSWORTH, ASSISTANT GENERAL MANAGER FOR ADMINISTRATION; W. KENNETH DAVIS, DIRECTOR OF REACTOR DEVELOPMENT; WILLIAM MITCHELL, GENERAL COUNSEL; DAVID F. SHAW, ASSISTANT GENERAL MANAGER FOR MANUFACTURING OF THE ATOMIC ENERGY COMMISSION

Mr. STRAUSS. Mr. Chairman, my colleagues and I are grateful for this opportunity of appearing before your committee. I have an introductory statement and there are supporting and more detailed statements that will be made by members of the Commission's staff. I would like to say that we have listened to Senator Gore's statement with great interest, and we have not had an opportunity to confer on it. There are a few points in it which with your permission and Senator Gore's, I would ask the privilege of commenting upon if time permits.

I particularly would like to say at this point, however, that I appreciate the generous statement in the penultimate paragraph in which the Senator states that he has an open mind on this program. I hope we all have, and that we can approach it in that light.

I will attempt, on the other hand, in the course of my presentation to expound our policy and that upon which we have been operating and which we believe to be correct.

Representative COLE. Mr. Chairman, may I inquire before Mr. Strauss proceeds, and solicit an explanation of the absence of Mr. Murray, who is a member of the Commission and who I understand expressed himself along the line of Senator Gore's proposal. I am curious to know why he is not here.

Mr. STRAUSS. Mr. Murray has left for the Pacific proving grounds of the Commission. I was not aware of the fact, but I believe he left on Friday or Saturday.

Chairman ANDERSON. May I say Congressman Cole, that I invited Commissioner Murray to make a statement. I suggested to him that Senator Gore would make his statement and the Commission would make its presentation, and the majority members of it, and if he had a minority statement, he could make it at the conclusion of that. He indicated that if he were to be here, he might do that and if he gets back in time before the hearings are closed he will make a statement. If he does not get back before the hearings are closed, he will submit a statement for the record and it will be inserted at the end of today's hearing.

(Commissioner Murray's submitted statement appears on p. 109.)

Representative COLE. Are we to understand that the remaining members of the Commission are in agreement, other than Mr. Murray?

Mr. STRAUSS. That is true with one qualification. We have an absent member who is ill, and these subjects have been discussed in his presence when he was able to attend our meetings, and I believe that our position fairly represents his view.

But since there has been no vote on the subject it would be unfair to represent him as subscribing to a particular course of action. Is there any difference of opinion on that?

Dr. LIBBY. No.

Mr. VANCE. No.

Mr. STRAUSS. I would like to interpolate one observation which is purely personal, with your permission, and which has not been discussed with my colleagues. As a matter of fact it only occurred to me this morning. That is with respect to a race with the Russians.

It seems to me we are peculiarly a people who are characterized by extremes, and there was a period in which we had a great tendency to underestimate Soviet capabilities in the scientific field and in the technical field. I am reasonably happy that I was in the minority, and I thought they could do better than it was generally supposed. It is my belief now that we have swung to the other extreme, and we are prone to overestimate them. That I offer as a philosophical observation, which perhaps you might tie into what I now with your permission would propose to say.

Representative COLE. You are continuing to operate as a minority in your viewpoint then.

Mr. STRAUSS. I would not say that. I have not tested that, Mr. Cole.

Senator PASTORE. You did mention to me, Admiral Strauss when I asked you the name or checked on the name of this Dr. Alvarez, that there is a full text to his statement that you would like to acquaint me with. I just read the newspaper report, and I know that the cyclotron goes to the basic science of this art. Naturally, of course, if we are outdistanced on the basic sciences, you know consequently in the future we will be outdistanced in everything else. Do you have any comment on that? Are you as much impressed with what Dr. Alvarez said?

Mr. STRAUSS. I am impressed that he is probably as competent an observer as we could have provided. The accelerators in Russia are, we understand, patterned after our own. The large one is a blowup, an enlargement of our Berkeley cyclotron. It is inevitable that as

these things are built those who undertake the most recent construction will have for a period of time the largest and the most powerful devices. We have under consideration and negotiation with the appropriate scholastic sponsors, one which when it is constructed will be larger than theirs. While it is building, in all likelihood, they will beat us. This is a race in which two horses are constantly pacing one another before they get into the stretch.

There is a substantial difference as I am certain you recognize, between high energy fission and the production of electrical energy from fission reaction.

Senator PASTORE. If that is true, why should Dr. Alvarez say that he was bowled over?

Mr. STRAUSS. He may have expected to see less than he saw. Not being there, I cannot answer.

Representative COLE. Could I ask a question there?

When he went over, and when Dr. Alvarez went over he had been told what to expect?

Mr. STRAUSS. I do not know, Mr. Cole.

Representative COLE. Well, you were told of this machine that he saw, and Dr. Summers described it to the delegates at the conference. So he went over having in mind and expecting to see something much bigger than existed in this country.

Mr. STRAUSS. When I go to Brookhaven, and see the accelerator under construction there, the details of which I am more or less familiar, and see that the excavation for it is half a mile in circumference, I am bowled over despite the fact that I know what I am going to look at.

The first cyclotron that was constructed by Dr. Lawrence could be held in the palm of your hand. One a half mile in circumference does have a capacity of bowling you over when you see it.

Mr. Chairman, we appreciate the opportunity of being with you this morning to discuss the Commission's civilian reactor program and possible means of accelerating it. Various matters affecting the progress of the civilian power reactor program have, of course, been discussed with your committee at different times during the course of this year, and particularly in connection with our report pursuant to section 202 of the Atomic Energy Act.

At the request of the committee we are presenting detailed reviews of the present state of the Commission's programs, both domestic and foreign, in the power reactor field, and of the state of the programs of other countries to the extent we know it. We shall also present specific comments on the bills introduced by Senator Gore and Congressman Holifield, to require the Commission to construct six full-scale nuclear power facilities. Prior to the presentation of these matters, however, I should like to discuss with you in broad terms the Commission's policy as to both the overall objectives of the United States in the field of civilian reactor development and the proper role of the Commission in furtherance of those objectives.

OVERALL POLICY OBJECTIVES

The Atomic Energy Act declares it to be the policy of the United States that "the development, use, and control of atomic energy shall be directed so as to promote world peace, improve the general welfare,

increase the standard of living, and strengthen free competition in private enterprise." In compliance with that objective the Commission has been proceeding on a broad front to develop all promising uses of atomic energy of which we have knowledge. The achievement of economical nuclear power will represent a technological breakthrough of very great importance, and we believe that breakthrough is certain to come. Accordingly, the Commission is acting on the principle that the development of economical nuclear power, both in the United States and abroad, is a program of prime national importance and urgency. I am sure there is no disagreement among anyone here with respect to that.

The question then is not one of objectives but of method. What is the best way to achieve economically competitive nuclear power, both at home and abroad? You will note that I emphasize the phrase "economically competitive nuclear power." We have proved that generation of nuclear power is technically feasible. Proof of our technical ability to generate substantial quantities of electric energy from nuclear sources has been publicly shown by the successful operation of the submarine *Nautilus*. I may interpolate there that we had the prototype of the *Nautilus* reactor operating in July of 1953, substantially ahead of any powerplant in the world, so far as we know, and certainly ahead of the Russian reactor mentioned by Senator Gore.

It is still operating, and I saw it a few weeks ago. It will be furnished again in dramatic form by the Shippingport pressurized water reactor which will begin producing from 60,000 to 100,000 kilowatts of electric energy next year. Incidentally, this, to the best of our knowledge, will be the first reactor of such size ever put into operation for the primary purpose of generating electric power. We have no doubt that the Shippingport reactor will work, and that other civilian and military reactors of various concepts can be built and will work, and we have brought with us, Senator, in case the committee would like to see them, some blown-up photographs of some of the reactors building, including Shippingport reactor, which are available if you wish.

Chairman ANDERSON. Since you mentioned there that this Shippingport reactor would be the first reactor of comparable size ever put into operation, for the purpose of generating electric power, perhaps that might be a good place for you to comment on the table which Senator Gore had in his statement as an appendix, or do you intend to do that later?

Mr. STRAUSS. I would like to do that later. I have some reservations about commenting on the table, but I will speak of that in a moment.

Representative COLE. In further reference to Mr. Strauss' characterization of Shippingport as the first reactor of comparable size, you mean in the United States or in the world?

Mr. STRAUSS. Anywhere in the world.

Representative COLE. I wish you had included that in your statement.

Mr. STRAUSS. I am sorry.

Senator JACKSON. That is being financed by the Atomic Energy Commission?

Mr. STRAUSS. Perhaps at this point I might interpolate as to the finances of that. I think that I touch on it later in this statement and I might wait. I have tried to cut the statement down, but I believe I left that paragraph in. If it is omitted I would comment on it because there is a very substantial amount of private capital involved in that enterprise.

Senator PASTORE. May I clear up one ambiguity?

You do not assume there is anything bigger in any other country when you say comparable size.

Mr. STRAUSS. Of that size or larger?

Senator PASTORE. That is what I wanted to get in the record.

Mr. STRAUSS. Thank you very much.

My attempts to get this statement in complete form, I see, were not as successful as I had hoped.

Senator PASTORE. Someone might say that they have one bigger.

Mr. STRAUSS. It will be compared, undoubtedly, in October with the first of the Calder Hall reactors in England to come on stream, and those reactors I have seen.

The primary purpose of those reactors is to produce plutonium for the British weapons program.

Chairman ANDERSON. But they will produce power in larger quantities than Shippingport.

Mr. STRAUSS. No, sir. Together they may, but the individual plants will not. It is said they will not. Sir Edwin Plowden did not claim a greater capacity for them than Shippingport.

The question is, however, at what cost will these plants work? It is because the primary problem in the United States is cost and no longer one of feasibility, that the Commission is actively engaged in exploring a large number of diverse reactor concepts. That exploration is proceeding primarily by the conduct of reactor experiments and associated research and development designed to develop necessary data with respect to the specific practicality, efficiency, and costs of a variety of systems.

We fully appreciate the importance of building full-scale reactors. Indeed there is a point at which only a full-scale reactor can provide the cost information and the engineering improvements that are necessary to achieve significantly lower costs.

But we believe that our present state of knowledge of some reactor concepts is short of the point where construction of full-scale reactors at this time is either necessary or advantageous.

In brief, our present goal is more scientific knowledge, not simply more kilowatts. While we advance on a broad front and with the vigor to achieve that knowledge, we believe we should continue to proceed toward that goal in an orderly and flexible manner.

This, in our view, means coordinating and timing both experimental and full-scale plants with the status of the particular areas of technology they are designed to explore and the nature of the information we can expect to get from them.

We believe that the enforced adoption of arbitrary goals of kilowatt capacity or numbers of full-scale reactors for an early date, such as 1960, is unwise because it would divert scarce technical skills from activities which promise greater results in subsequent years.

THE KILOWATT RACE

Concern has been expressed that we are losing a kilowatt race because other countries have announced plans for constructing reactors which might result in their having, within a few years, more kilowatts of nuclear capacity than we do. Some people feel that their announcements are more to be relied upon as dates of completion than the arrangements we have made with American industry. I do not share that feeling.

Representative PRICE. Mr. Strauss, it is shared by responsible Government agencies, though?

Mr. STRAUSS. I said that I do not share that feeling.

Representative PRICE. But other Government agencies do evaluate the possibility that that may be true.

Mr. STRAUSS. I cannot answer, and I do not know as to that, Mr. Price.

The mere number of kilowatts of capacity to be in existence by 1960 is not, in our view, very meaningful. There may be a number of reasons why a nation might decide to construct nuclear powerplants before they have been proven to be economically competitive according to our standards.

Such a nation may have power needs which cannot be satisfied by conventional means. Or it may have conventional power costs of such levels that even high-cost nuclear power looks attractive. Or a nation may have decided to embark upon a program of dual purpose reactors in which the allocation of costs between plutonium and electrical energy is a matter of internal accounting adjustable either way since both their nuclear weapons program and their power programs are Government monopolies.

That is the case in England. Or, it may feel that kilowatt propaganda justifies the excessive costs involved. These reasons are not valid in the United States.

If there were some logical reason for doing so, the United States could unquestionably build millions of kilowatts of nuclear generating capacity by 1960—but it would not be economically competitive power. We do not consider the fact that some other countries have announced plans to build a specific kilowatt capacity a persuasive reason for us to start a crash program to outmatch them.

We believe that our program should continue in its present direction and that we should not risk its success by shifting ground in order to compete with announcements of other nations.

I hope I will not be misunderstood. It is important that we maintain world leadership in the development of nuclear power. However, this ought to be genuine leadership based on sound scientific progress and technological development.

We are confident that our present program now enjoys such a position of leadership. We are constantly reviewing the power reactor programs of other countries and so far as we have been able to discover we are not behind any country. We have an expanding and aggressive reactor development program which we are convinced will develop the best possible technology and enable us to maintain our position of leadership.

Technological leadership is, of course, difficult to measure and the assertions I have just made as to the state of our research and develop-

ment program rest in part on the informed judgments of experts. However, there are some objective yardsticks of our country's present position. One was the Geneva Conference on the Peaceful Uses of the Atom. Some of the members of your committee, and you yourself attended that conference and at its conclusion complimented us upon our showing.

While we were honestly impressed with the fine work that several other countries have done in the field of atomic energy, it was, I think, apparent to all observers that the magnitude and quality of our effort and our achievement was far and away the most outstanding. A more recent indication exists in the fact that private American industry has sold 3 research reactors and 1 power reactor to foreign countries.

So far as we are aware, no other foreign government or industry has made any such sales.

THE ROLE OF THE COMMISSION

Not only do we feel that there is no real virtue in having the Government merely construct kilowatts of generating capacity, we are also anxious to avoid Commission construction of large-scale plants if the desired knowledge can be obtained by other reasonable means.

In its report on the bills which became the Atomic Energy Act of 1954, your committee made the following statement:

> We do not believe that the efforts of free enterprise, using its own resources and moneys, are by themselves adequate to achieve the speediest possible attack on the goal of peacetime power. Neither do we believe that maximum progress toward this objective will be afforded by an effort relying exclusively on governmental research and development, using the public's moneys. We believe, rather, that teamwork between Government and industry—teamwork of the type encouraged by these amendments—is the key to optimum progress, efficiency, and economy in this area of atomic endeavor. In other words, our legislative proposals aim at encouraging flourishing research and development programs under both Government and private auspices.

We believe that the philosophy expressed in this statement was sound when it was adopted and that it is still sound. We believe that the attack on the difficult developmental problems which we face can proceed most effectively through the combined efforts of Government and industry.

To make the most efficient use of those efforts, however, requires some analysis of the special capabilities of each. In general, we believe that the emphasis of governmental research and developmental work should be on the earlier stages of design, feasibility, and experiment, whereas the emphasis of private industrial effort should be on construction of prototypes and their operation. We believe this for several reasons.

First, the kind of information which we are trying to get out of the construction of prototype plants can better be obtained if these plants are constructed and operated by private or cooperative businesses.

One of the major purposes in constructing a prototype is to obtain reliable cost data and to explore all possible avenues for cost savings in an actual large-scale construction effort. This can best be accomplished where there are normal industrial and commercial incentives; in other words, where industry takes the primary technical and financial responsibility.

While some governmental assistance will be appropriate, as in the power demonstration reactor program, we have sought to make that assistance available in a form which will not impair the technical responsibility, nor dilute the normal incentives of business.

We do not believe that vital cost reductions will be as quickly achieved under Government cost contracts. We think such cost reductions can be most expeditiously achieved under arrangements where the burden of any excess costs and the benefits of any savings will be reflected in the profit and loss account of American business.

Chairman ANDERSON. Will these excess costs that you refer to be absorbed by these power companies or will they be passed on to the consumers?

Mr. STRAUSS. The excess costs in any business are included in the product which the business sells. If the General Electric Co. in selling motors, manufactures them at a cost in excess of what their competitors manufacture them for, they are included in the selling price of the motors. It is inescapable that the cost of the product is reflected in the selling price of the product.

Senator JACKSON. It is a little different in the case of utilities. They are guaranteed a certain return on their investment capital, Mr. Strauss. It would not be exactly the same as with a nonutility business.

Chairman ANDERSON. And the larger the invested capital, the greater the permissible rate as long as the utility stays in business.

Representative COLE. Let us make sure it is a permissible rate and not a guaranteed rate, however.

Mr. STRAUSS. There are public bodies that regulate these things.

Senator JACKSON. If they do not get their return, they have a right to an increase in their rates. They can make application and it has to be approved by the public service commission or the body set up by State law.

Mr. STRAUSS. I would think, Senator, although I am speaking from ignorance rather than knowledge, that any experimental work whether it is in the field of atomic energy or otherwise carried on by a public utility would be reflected in its profit-and-loss account, but this is a matter that undoubtedly some of you who deal with the Federal Power Commission are far more competent to deal with.

Senator PASTORE. The point you mean to make is that there is always an incentive there to reduce those costs because of the howl that might come from the consumer and the regulating authority. There you have an incentive to reduce costs. If you are going to get the Government into this business, the responsibility of the taxpayer with relation to this one particular specific project is so far removed that sometimes you do not get that connection with the howl, that is the cause and the effect.

Mr. STRAUSS. I would think so.

Another type of information that we expect from a prototype plant is operating experience. This too, we believe can best be obtained when the plant is operated by an existing utility organization—publicly, cooperatively, or privately owned—and when the reactor energy is used as an integral part of such a utility system. In this way, the operation of the prototype will most nearly duplicate the operating conditions to which commercial plants will be subjected.

A second reason for the Commission's preference that industry construct prototypes concerns the kind of effort which must go into the construction of a full-scale plant. The construction of six large reactors such as the reactors which the bills introduced by Senator Gore and Representative Holifield contemplate would be a job approaching the magnitude of the Commission's Savannah River project—though more difficult because of geographic scattering.

The Savannah River project, as you will recall, involved 5 reactors, together with related feed materials, processing and servicing facilities, all of which would have to be provided if the Commission were now to build 6 prototype power reactors.

Chairman ANDERSON. Do you have any feeling that the Savannah River experience shows the job can be done if the Government wants badly enough to do it?

Mr. STRAUSS. There is no question as to its feasibility, Senator. There is no question in my mind also that if we started it now, it would not be finished before 1960, if we began it immediately. Adding this amount, Senator, would still leave you the loser in the power race if kilowatts installed is the answer and if you believe the figures in the Russian announcement.

Chairman ANDERSON. What was the time of Savannah River? Was it 4 years?

Mr. STRAUSS. It was 3½ to 4 years.

Mr FIELDS. That is correct, sir.

Chairman ANDERSON. Has it not been calculated that we could do something similar to that in 2½ years?

Mr. STRAUSS. These plants are to be all different, each a different concept, and each in a different part of the country. I simply submit that if the purpose of this is simply to out match the Russians in kilowatts, it does not do it. You would have to increase the bill.

Chairman ANDERSON. Could we do it plant by plant? Instead of saying they are all different, let us say that it was desired to build a plant, and not six, but a plant like the Savannah River Plant where the primary purpose would be power and the secondary purpose would be something else, say plutonium, rather than a single purpose plant for weapons programs. Could that not be done in a period of 2½ to 3 years.

Mr. STRAUSS. I would assume, Senator, that a Chinese copy of the reactors at Savannah River could be built in less time than was required to build them initially, but I would not want to venture a guess on that.

Senator JACKSON. Did we not make a much better record at Hanford on the piles that were built there later?

Mr. STRAUSS. The subsequent piles at Hanford?

Senator JACKSON. Yes, I am referring to later additions. It seems to me they were completed in a little over 2 years from the time construction started. I may be wrong.

Mr. STRAUSS. I doubt that.

Senator JACKSON. I think it was less than 3 years.

Mr. STRAUSS. I doubt whether they were completed in 2 years but I am unable to give you a figure on that.

Senator JACKSON. Mr. Shaw is here, and I think that he could answer that.

Mr. SHAW. The best time we made on any of the Hanford reactor areas was about 30 months, 2½ years. This was for a completely going reactor.

Mr. STRAUSS. That was repeating something which we had built and the drawings and blueprints and specifications were all there.

Senator JACKSON. How long would it take you at Hanford to build a dual purpose reactor?

Chairman ANDERSON. That was to be the next question. Now, we have a long study at Hanford. The General Electric Co. as I understand it, and I have never seen it, submitted some sort of a suggestion for the development of power at Hanford, so they must have given it some thought. The whole proposal was submitted to the Atomic Energy Commission and it knows what the proposal was that was submitted to it.

That was the second plant. Suppose it was desired that a plant be built at Hanford along the lines of the G. E. proposal? The primary purpose might be power and the secondary purpose plutonium. Could that not be done in 2½ years?

Mr. STRAUSS. I cannot answer that, but I can say this positively: On the basis of the best advice that the Commission has been able to receive, a plant designed for the production of other than power, that is to say, if plutonium is a feature of the design, will provide no reliable cost data on the production of power. The Commission sometime in early 1953, a date prior to my return, took the position that it would not build dual-purpose reactors.

Chairman ANDERSON. Precisely, but as a good businessman, Admiral Strauss, you would recognize that what might be attractive at Hanford where current was 2½ mills from the Columbia River, if that plant might be ruled out because it developed a cost that was 3 mills, 3-mill power would be pretty attractive in some parts of the United States.

Might not a plant that was going to do the job that General Electric had in mind at Hanford be built in another part of the country?

Mr. STRAUSS. Nobody has suggested to us so far as I know, Senator, a plant to produce power at 3 mills.

Chairman ANDERSON. May we have the General Electric study at some later time?

Mr. STRAUSS. If it is not already in the hands of the committee, the general manager will see that that is done.

Senator JACKSON. It depends on the cost of your plutonium, what you have for that. You can reach any figure you want.

Chairman ANDERSON. I carefully avoided a discussion of that, and I think perfectly in the open you could say whatever the cost of plutonium was elsewhere, that is a proper charge for plutonium there.

Senator JACKSON. Surely.

Chairman ANDERSON. Starting with that assumption, I believe you have had a 3-mill study and I think that we will be glad to look at the Hanford situation.

Mr. FIELDS. In conjunction with this proposal by G. E. some years ago, there is research and development even with that proposal that would have to be done to adapt the Hanford designs to a dual purpose reactor.

Chairman ANDERSON. Assuming that the plutonium charge was to be the same as the other plutonium costs, was there a 3 mill figure in connection with it?

Mr. FIELDS. There was not a 3-mill figure and I would have to go back to find out the figure. I am quite certain that it was higher than that figure, sir. But the point as to the time, I do not believe that you could do this in a matter of 2½ years with the research and development that you have associated with that to put a dual purpose reactor under construction.

Senator JACKSON. The British are proceeding on the dual purpose basis, are they not?

Mr. STRAUSS. They have very good reasons for doing that, Senator Jackson, which it would not be appropriate to discuss here. But they would not do so except under necessity.

Senator PASTORE. May I ask a question at this point? Looking at this whole panorama and considering the progress that we desired to make in the development of this art, what essential benefit or disadvantage would there be in building this dual purpose reactor at Hanford? What would be your observations on that? Would it help us at all in this progress we are trying to make, or would it add nothing?

Mr. STRAUSS. The Commission concluded that it would add nothing since the goal is economic power, and since that would not give us any adequate cost figures on the production of electrical kilowatts it concluded not to do so.

We make plutonium in reactors that are designed to make plutonium as cheaply as we can make it and our unit costs have been steadily declining. We hope to make power in reactors designed to make power with the same end in view.

Senator, I find that the next sentence was a response to your question as to whether the Commission could undertake this enterprise.

The Commission is, as you know, historically capable of taking on huge construction efforts; it has done so successfully on a number of occasions in the past. However, the point you should not overlook is that in the construction of these proposed plants, a major portion of the effort would be devoted necessarily to ordinary procurement and administrative problems involving concrete, bricks and mortar, standard electrical machinery and hardware, rather than to nuclear technology.

From the point of view of limited numbers of highly qualified people available to us, this would not be a sound employment of skills.

A final reason why we are reluctant to build full-scale prototypes is that such prototypes will serve their purpose only if they generate and distribute substantial quantities of electric energy.

Chairman ANDERSON. At Duquesne where the Government is putting up a large share of the research and development costs, and a large share of the construction costs, I used a figure of 90 percent but that has to be interpreted a whole lot because it will never happen again. But the Government is going to pay for the nuclear part of that project up there.

It involves concrete, bricks and mortar, standard electrical machinery and hardware. How much time does the Government spend on concrete, bricks and mortar up there?

Mr. STRAUSS. A great deal, Senator. That project, if you will recall, was initiated by the Commission under the old act. We did not have the benefit of the 1954 act. We succeeded in obtaining from the Duquesne Light Co. a contribution of $5 million of their stockholders money to the Government end of that plant. They contributed a site, and they will pay for all of the operating personnel, and they will buy from the Government at, I believe, 3 mills per kilowatt-hour over and above the amount for what they could produce it by burning conventional fuels. They also pay for the entire generating portion of the plant.

Chairman ANDERSON. Are they not buying the concrete?

Mr. STRAUSS. You mean actually placing the orders?

Chairman ANDERSON. Are they not buying the sacks of cement?

Mr. STRAUSS. I do not know how the details of that are handled.

Chairman ANDERSON. I am trying to say that the very thing you did at Shippingport, which is holy and sacred, is impossible in the other installations.

Mr. STRAUSS. I have not said impossible. I have said it would be a diversion of effort.

Chairman ANDERSON. Did you divert any effort in concrete bricks and mortar?

Mr. STRAUSS. I think this took considerable time in our reactor development division.

Chairman ANDERSON. I was up at the site and I did not have a single explanation of the construction work from a representative of the Atomic Energy Commission. I had the impression, and I may be wrong, that Duquesne had something to do with that contract.

Mr. STRAUSS. They have a great deal to do with it, but on the other hand, I am afraid I do not get your point.

Chairman ANDERSON. My point is that if you wanted to build, as General Electric wanted to build, at one time, a duplicate of the Hanford plant but designed primarily for the production of power and secondarily for plutonium, the General Electric is just as competent to do that as it is to do something else, and not a single employee of the Atomic Energy Commission is going to have to bother with concrete, bricks, or mortar.

Mr. STRAUSS. That is perfectly true.

Chairman ANDERSON. I do not believe that at Savannah River, where you had the Dupont people there, the representatives of the Atomic Energy Commission were concerned with concrete, bricks or mortar. If they were, it would have been impossible to have put that into the contract and let Dupont do it.

Mr. STRAUSS. We review every item of their expenditure, and we have a staff of people there, and a careful audit is run.

Chairman ANDERSON. I am only trying to suggest that while I have, I trust, an open mind to the Gore bill, I did not join with him on the bill because I do not think there are some great problems in connection with this. I wonder if saying that the Atomic Energy Commission would have to look at the application and mortar and hardware is a fair criticism of the bill. He is trying to suggest that in addition to the private effort that the Commission is sponsoring and pushing and I think commendably so, for these additional plants, Commonwealth, Consolidated, and Detroit Edison and various other ones, it

might be possible to have a Government program pushed at the same time.

The Government has succeeded in building a plant costing over $1 billion without having to worry about the concrete and the bricks and the mortar.

Mr. STRAUSS. We do worry, Senator. You would find that the construction division of the Commission follows these expenditures and these purchases with great care, and the general manager at frequent intervals, and the Commission once a month, receives a report on the degree of completion of each component of the plant. There is a necessary responsibility to follow this construction.

Chairman ANDERSON. I realize that, but I remember the job at Joppa, the one they referred to as the "Ebasco fiasco," where we got doors that cost $400 and things of that nature. The General Accounting Office objected to them and the answer was that the Atomic Energy Commission had nothing to do with the purchase of those.

Mr. STRAUSS. That was quite a different thing. That is not a Government plant.

Chairman ANDERSON. But it is an electrical plant that the Government is going to pay for on the current that it buys. I am only trying to say that all over the United States there are examples of people who get a contract to give the personnel desiring the plant a turnkey job and you never have to look back at any stage of the game. The Austin Co. recently came in to our area and produced a very substantial plant. They did the whole job, and nobody connected with it had to worry about it.

I am only trying to see if we could not separate from the objections to the Gore bill, the physical task of buying bricks and mortar.

Mr. STRAUSS. I would be perfectly willing to have that separated. I think it is de minimus by comparison with the policy questions which I have attempted to outline. The final one is this: Once the Government has built a successful 100-megawatt plant, it will have 100 megawatts of electricity to dispose of, not merely for the period of time during which the plant is serving a primary research and development function, but during its entire life. The disposition of such quantities of electricity would present the Commission with a host of admnistrative problems which in our view could prove a significant distraction from our primary responsibilities as laid down by law. While these problems might be reduced in magnitude by specific provisions relieving the Commission from any responsibility for the distribution of energy, they could scarcely be wholly eliminated.

Senator PASTORE. Could I ask a question at this point? I may be anticipating a little bit, and if I am, I withdraw my question. If the Government itself were building these six plants as suggested in the Gore bill, what would be the procedure followed, and to whom would we go, and how much would this distract from private enterprises to venture in this field?

Mr. STRAUSS. The bill does not spell that out, Senator.

Senator PASTORE. I wonder what would be the practical aspects of the problem. In other words, could you successfully carry out a full-fledged private enterprise development in this particular field, and still have the Government building six plants of its own, and would you have enough technicians, and scientists or would one have to sacrifice to the other?

Mr. STRAUSS. We think that is a sacrifice and that is a matter of opinion, of course. My statement will have to be weighed by the fact that it is a statement supported only by the views of my colleagues and by our staff. Others may differ with it. We think that there is a short supply of the kind of skills that we would need and that we would have to divert people from research and development which we believe is more important.

Senator JACKSON. You do not mean, Admiral, that we should not try to move forward in this field because we are going to have to use scientists and technicians. We would not want to create that impression, would we?

Mr. STRAUSS. I do not regard this as moving forward in the field. I think that is the difference between us. I think to build these plants——

Senator JACKSON. What if the private companies build these plants, would that be moving forward?

Mr. STRAUSS. The private companies cannot build plants without obtaining a license and they do not obtain a license without a showing approved by the Commission as to the purpose of the project.

Senator JACKSON. But what is the difference? The private utilities are building some, as I understand it, and we have had that testimony of what they are proposing.

Mr. STRAUSS. That is right.

Senator JACKSON. Would you consider that if the private utilities built them, that is, or is not, moving forward in this field? I assume that they must feel that it is important to their own future for them to undertake this effort.

Mr. STRAUSS. They feel it is important to the future of the country and their own future and as you will see in a few moments in the course of this statement each time we have a significant reactor project we have obtained the cooperation of private industry in its construction.

In the event that a reactor design is offered which private industry does not move forward to undertake, I personally would recommend to the Commission and I believe the Commission would under those circumstances undertake to construct it at Government expense. As I will point out in a moment, there is adequate authority in the existing statute for that.

Senator PASTORE. Before you do that, I think that my question has been somewhat misunderstood. I have already said that I go along with the Gore philosophy that there ought to be some supplementation to the entire program.

Now, I am questioning as to whether or not that would constitute a strain on the program?

Mr. STRAUSS. We believe so.

Senator PASTORE. That is the point I mean to establish. This job needs to be done and now there are only so many people that can do the job. Now, if we supplement it with a Federal participation, in building six reactors of their own in addition to what private industry is expected to do once some of these obstacles are removed, would we be in effect accelerating the program, or would we be stepping on one anothers' toes insofar as the same people who are able to build this is concerned? That is the point I raise. Would we actually be expanding, or would we actually be dividing between ourselves?

Mr. STRAUSS. We think that we would be building obsolescent plants with scare talent instead of moving forward into new areas.

PRESENT STATUS OF THE UNITED STATES POWER REACTOR PROGRAM

Probably the real issue is whether or not the Commission's program is proceeding rapidly enough toward the goal of economic nuclear power. If the Commission believed that it was not, and that construction, at public expense, of large numbers of kilowatts of generating capacity was the best way to advance that goal, we would recommend an appropriate program for the construction of prototype powerplants, notwithstanding our reluctance to be in the business of building and operating full-scale nuclear power generating facilities.

I am not inclined to be content with our record of accomplishment. I would like to see more being done and more rapidly. But there exists a mistaken impression that because ground is not now being broken on a large number of full-scale prototype plants, the reactor program of this country in consequence is static.

Nothing could be farther from the truth and your committee, of course, knows this both from our testimony and from the evidence of your own visits to our laboratories. The account of the state of our power reactor program which we shall present later today will show this in detail and bring it down to date.

Some of these photographs are quite impressive. As I have said, we do not regard kilowatts as the measure of accomplishment. But even in kilowatts, our progress is substantial. We believe, based on present announced plans, that we will have some 800,000 kilowatts of nuclear generating capacity in existence in this country by the very early 1960's.

I do not include the number of kilowatts of generating capacity in plants which will be sold by our manufacturers abroad. Additional plants may soon be announced which would considerably increase this figure. In view of the low cost of conventional power generation in this country, it would be reasonable to expect that the United States would be one of the last countries in which nuclear power would be used as a major source of electric generation.

Nevertheless, the construction of this large nuclear capacity, in the face of the intense competition which it must meet from very efficient low-cost conventional energy, is, I submit, a reliable indication of the healthy state of our nuclear technology. Additionally, United States industry—using United States technology—is more than holding its own in competition with other nations for contracts for research and power reactors around the world.

MEANS OF ACCELERATING THE COMMISSION'S PROGRAM

In sum, we have a civilian power program that is presently accomplishing far more than we had reason to expect in 1954. I would interpolate there that there has been no breakthrough in power development since 1954, since 1953, or 1952, and yet the concern of this committee is that we have not moved more rapidly in the last 2 years.

We have a flexible program in which the decisions can be made promptly for each reactor concept as to when and how to proceed from

feasibility study, to more extensive research and development, to experiments, to prototype, and then to commercial plants.

It would be a serious mistake to destroy that flexibiilty by adopting arbitrary goals of kilowatts of capacity or numbers of full-scale reactor plants without carefully weighing the contribution or the handicap which such arbitrary goals would make or impose toward our ultimate goal of achieving competitive economic nuclear power.

I believe that any steps which we take to accelerate our progress should be in the context of complete flexibility. I also believe that we should avoid charging the Commission with the responsibility for substantially proven construction, and for the generation and sale of electricity—unless it is clear that our goal of acquiring additional scientific knowledge to ensure our technological leadership cannot otherwise be achieved.

In closing I would like to suggest some things that we can appropriately do with your assistance to push our program forward.

First I would note that the law presently authorizes us to build and operate nuclear powerplants for research and development purposes.

Chairman ANDERSON. Did you not vary a little from that in the Shippingport pattern? You did not wait until everything was worked out completely before it was built.

Mr. STRAUSS. Senator, we had a plant in the desert and a plant in the *Nautilus* which assured us that we had every reason to expect that the larger plant at Shippingport on the same principle would work.

Chairman ANDERSON. Precisely, and now, at Hanford and Savannah, you have reactors that have been tested, and you know they will work, and they have the longest operating schedule of any. Why should not the Hanford reactor be permissible on the same basis?

Mr. STRAUSS. They are so entirely different in design.

Chairman ANDERSON. From what they would be in plutonium and power?

Mr. STRAUSS. From a power reactor.

Chairman ANDERSON. You mean that the transformation of the Hanford reactor, so that it made power as well as plutonium would be so substantial that they would not be able to get underway with it for a long time?

Mr. STRAUSS. I raised the question 2 years ago as to whether a Savannah-type reactor could not be adapted to extract power, and I was told that it would be cheaper to build another reactor than to undertake to convert those.

Chairman ANDERSON. I am not suggesting that. We will need our Savannah reactor and we will need our Hanford reactors for the responsibilities we have ahead. I am only asking, and I am asking it for guidance, would it not be possible to take the things we have learned at Hanford, and the things we have learned at Savannah River, and build a new reactor based upon the principle, one at Hanford and one at Savannah, that would be primarily for the production of power and secondarily for the production of plutonium, and do it very quickly?

Mr. STRAUSS. I do not believe I would be competent to give you an answer with which you would be satisfied.

If I did, I should be stepping out of my role. This is a question for the technicians and not for an administrator.

Chairman ANDERSON. Could not the Commission give an answer to that?

Mr. STRAUSS. We should do that, and we can do that.

Dr. LIBBY. I would not care to amplify that at the moment, but we can supply you with an answer.

Mr. STRAUSS. We will give you an answer to that in a very few days.

Chairman ANDERSON. That is all right.

(The information referred to is classified and will be filed with the Joint Committee.)

Mr. STRAUSS. In closing, I would like to suggest some things that we can appropriately do with your assistance to push our program forward. First, I would note that the law presently authorizes us to build and operate nuclear powerplants for research and development purposes. That is the present law. That was one of the very desirable changes that were made in 1954. We are prepared to exercise that authority, and to request authorization and appropriations for such plants, whenever it appears to us——

Chairman ANDERSON. That came in when we took out the Johnson amendment that would have required you to build these plants covered now by the Gore bill, and they said, "You do not have to put a provision in there or put in permission for them to build them, and the Atomic Energy Commission will go ahead and build them."

Well, after 2 years, we did not think the plants were being built, and I think that is the explanation of the Gore bill.

Mr. STRAUSS. I am going to ask you to let me show you something along that line.

We are prepared to exercise that authority, and to request authorization and appropriations for such plants whenever it appears to us as a true test for this effort, that we have developed a reactor concept sufficiently to make it timely for the construction of a prototype, and when, after appropriate public invitations for proposals for joint AEC-industry projects, it ever appears that industry, cooperative or private, is not prepared to undertake such construction. Thus far, industry has not failed to meet each situation.

However, should a promising new reactor concept be ignored or rejected by industry while I am Chairman, I would recommend that the Commission build a prototype nuclear powerplant to prove out the new reactor concept.

Secondly, we believe that in certain areas further steps should be taken to encourage industrial construction of reactors. The most important of these is in the field of insurance protection, on which we presented our views to the committee last week. We urgently recommend that Congress act on this subject at this session.

I would like to interject here an earnest and prayerful "Amen" to the hopes expressed around the table that the action will be taken at this session.

We also think that the legislative action should be taken——

Chairman ANDERSON. May I break in to say that we have a bill which your Commission has sent us, and we have a bill which our staff has worked up, and we hope to be able to have a quick hearing on both because the views have already been pretty well expressed.

We hope that that hearing will not last more than 2 days, and then the committee can report a bill to both Houses if needed so that they may be scheduled for action within the next few weeks.

Now, what the leadership of the two Houses will do is outside of our province, just as many things are outside of your province.

Mr. STRAUSS. The very great influence of this committee, I am sure, will be sufficient to pass it, and I take comfort, Senator Gore, from a sentence that you interpolated in your statement in which you said that you would be willing to help by voting for the removal of obstacles. I sincerely hope for your support.

Senator GORE. I believe that I said, "reasonable concessions."

Mr. STRAUSS. I am not a very good court reporter. I wrote as fast as I could.

We also think that legislative action should be taken to facilitate Public Utility Holding Company Act exemptions of limited duration. Our views on this have been expressed in hearings before a special subcommittee of the Senate Committee on Interstate and Foreign Commerce.

That is not forever, but as Senator Pastore said, for a limited duration.

Chairman ANDERSON. We feel that the hearing which Senator Pastore held on the Potter and Pastore bill was a satisfactory hearing. I am sure that Senator Pastore will move rapidly with it, and I am sure that he will have the cooperation of every member of our committee in trying to see that action takes place.

There were questions in his mind, and I am sure that there were questions in ours, as to how far he should go. It is a somewhat difficult matter. You had contradictory testimony, I believe, from two Government agencies.

Senator PASTORE. That is right.

Mr. STRAUSS. That is not so unusual nowadays. In any event, we are extremely grateful for the assistance of your committee and your subcommittee, Senator Pastore, on this and I cannot imagine anything that would do more to advance the production of nuclear power at the moment than the passage of those two pieces of legislation.

Thirdly, we believe that vgorous action will be necessary to relieve the shortage of technically trained manpower. We have discussed this problem with your subcommittee of which Congressman Price is chairman and have indicated the general nature of legislation which we think would be desirable and helpful.

Furthermore, the Commission should be able to pay its technical and professional staff members salaries that are commensurate with their responsibilities and more nearly competitive with salaries now being offered by private industry.

That will protect our organization.

Chairman ANDERSON. I think that we have taken some action on that. I believe that we approved the scale that we thought was reasonable, of increases, and submitted it back to the Commission, did we not?

That was for informal review.

Mr. STRAUSS. That review will be completed this afternoon, I think.

Chairman ANDERSON. I want to say to you, Mr. Chairman, that it follows pretty closely the recommendations we think that the Atomic Energy Commission made.

Mr. STRAUSS. I am very grateful for that. We know we cannot compete with industry, and we simply want to be able to give our people some incentive beyond the spirit of dedication that animates

most of them today, and binds them to us. Without them, we would be absolutely helpless.

We hope that perhaps some members of your committee will have other ideas as to what we could be doing to accelerate our program. We will welcome any suggestions which you may have, consistent with those principles which we think are basic and I have an open mind like you, Senator Gore, and which I have tried to outline.

As I have said, I believe we are all in agreement as to our ultimate objective—to keep our country in the lead in the development of scientific knowledge which will enable us to make the atom an economic as well as a beneficent force for human welfare, here at home and abroad.

Chairman ANDERSON. Now, Mr. Strauss, it is 12:30. Would it be convenient for you to return at 2 o'clock for questioning, rather than to try to hasten through questioning now?

Mr. STRAUSS. At any time that you say, Senator.

Chairman ANDERSON. We will adjourn until 2 o'clock.

(Whereupon, at 12:30 p. m., a recess was taken until 2 p. m., of this same day.)

AFTERNOON SESSION

(The hearing was resumed at 2 p. m.)

Chairman ANDERSON. We will come back in session again.

The next witness is Mr. W. Kenneth Davis, the Director of the Division of Reactor Development of the Commission. Mr. Davis will deal with the unclassified material in the reactor section.

Then when we have finished with Mr. Davis, if we desire to question either Chairman Strauss or Mr. Davis on the reactors we can do so at that time. It might save some time to go ahead with Mr. Davis at this time. We can delay questions of Mr. Strauss because some of the questions might be answered by the testimony.

STATEMENT OF W. KENNETH DAVIS, DIRECTOR OF THE DIVISION OF REACTOR DEVELOPMENT OF THE UNITED STATES ATOMIC ENERGY COMMISSION

Mr. DAVIS. I will speak on the status of the AEC civilian power reactor program.

The many reactor experiments, experimental reactors and demonstration power reactors now being built or planned within the Commission's civilian power reactor development program have been described in detail to the Joint Committee on Atomic Energy in earlier communications or discussions. We have prepared a report on the current status of this program in accordance with the committee's request. This report is hereby submitted for the record. We have copies of this report here for submission to the record and after I have read this preliminary statement, if you would like me to go through this report and discuss it, I would be glad to do so. I do not plan to use it for these preliminary remarks. Rather, I believe it may be helpful to discuss the status of civilian power reactor technology in somewhat more general terms.

(For AEC statement on Status of Foreign Reactor Program, see appendix, p. 540.)

(The status report referred to follows:)

UNITED STATES ATOMIC ENERGY COMMISSION

STATUS REPORT ON THE CIVILIAN POWER REACTOR PROGRAM

I. Introduction.
II. Pressurized water reactors.
III. Boiling-water reactors.
IV. Sodium-cooled reactors.
V. Fast breeder reactors.
VI. Aqueous homogeneous reactors.
VII. Other reactor concepts.
VIII. Engineering development.

Chart 1—Developing civilian atomic power.
Summary of projects.
Chart 2—Civilian power reactor development.
Status of projects, parts 1 and 2.
Table I—Parts 1 and 2: Summary of major power reactor experiments.
Table II—Parts 1 and 2: Summary of prototype power reactor plants.
Charts:
Total and nuclear generating capability.
Transition to nuclear power.
Diagram:
Coal-steam generation.
Pressurized water reactor.
Boiling-water reactor.
Sodium-graphite reactor.
Fast breeder reactor.
Aqueous homogeneous reactor.
Organic moderated reactor, liquid metal reactor, gas-cooled reactor.
Photographs:
PWR—Shippingport, Pa.
EBWR—Argonne National Laboratory.
SRE—Santa Susana, Calif.
HRE—Oak Ridge National Laboratory.
APPR—Fort Belvoir, Va.

(NOTE.—Some of the photographs and charts above have been filed with the Joint Committee.)

I. INTRODUCTION

The experimental program

The civilian power reactor program was formalized in February 1954. Prior to that time, extensive research and development work, and in some cases construction and operation of reactors had developed a substantial amount of information on 80 or more reactor concepts.

In February 1954 five of these concepts were selected for extensive development in a Government-financed experimental program covering a 4- to 6-year period. These five concepts were those which were judged to be potentially capable of producing economically competitive nuclear power and to be sufficiently well advanced in technology to make construction of experimental reactors technically feasible. The five concepts were the pressurized water, boiling water, sodium graphite, fast breeder, and homogeneous.

While intensive work proceeded on these five concepts, research and development continued to explore the possibilities in other types of reactors, with the result that three additional concepts were chosen for development in the experimental program. These concepts are the organic-moderated reactor, the liquid metal fuel reactor and the gas-cooled reactor. More recently a project has been added to be used primarily to test plutonium recycle techniques in thermal heterogeneous systems.

Each of these reactor concepts is discussed in the following sections of this report.

The power demonstration program

The Commission's report to the Joint Committee in March 1954 on the civilian power program expressed the hope that the new technology developed in the Government-financed experimental program "will encourage industry to take

over an increasing share of the financing of further research and development and to consider with increasing favor the actual construction of pilot or full-scale powerplants." It was further stated that the experimental program was "based on the assumption that the law will be changed to make industrial participation in reactor development more attractive."

Following passage of the Atomic Energy Act of 1954 the Commission initiated a power demonstration reactor program designed to enlist private resources and initiative in the nuclear power field. In January 1955 the Commission invited proposals whereby industry would undertake to develop, fabricate, construct, and operate experimental reactors. In return the Commission offered to consider:

1. Waiving established Commission charges for loan of source and special nuclear materials for a period up to 7 years beginning July 1, 1955.
2. Performing research and development work in AEC laboratories, either without charge or at reduced charges.
3. Making payment, to be fixed in advance, for technical and economic information resulting from the project. (The fixed-sum basis for the Commission's contribution was decided upon in order to maximize the industrial participant's economic incentives to make cost reductions.)

As a result of this first invitation, four proposals were received, one of which was later converted to an outright license application.

In September 1955, a second invitation was issued under this program. The types of assistance offered by the Commission were slightly modified based on experience with the first invitation. Also, electrical generating capacity ranging from 5,000 to 40,0000 kilowatts was specified. In addition to the value of these sizes to publicly owned and cooperative electric power systems, they are also appropriate for some of the high-cost power areas of the world where an early introduction of atomic power appears likely to be most needed. Before the closing date of February 1, 1956, seven proposals were received. It is noteworthy that each of the proposals called for a reactor of a different type.

The proposals received in response to the two invitations are tabulated in chart 1, and the status of the proposals is shown in chart 2.

The independent industrial program

In addition to the plants proposed under the power demonstration reactor program, the electric utility firms or group of firms have proposed five plants for construction without Government financial assistance. On three of these construction permits have been applied for and issued. These proposals are listed on chart 1, and their status is indicated on chart 2.

There has been additional tangible evidence that American firms are responding to the opportunity provided by the Atomic Energy Act of 1954 to get into the atomic-energy business. The General Electric Co. has been selected by the Spanish Government to build Spain's first atomic reactor. Atomics International, a division of North American Aviation, Inc., has been chosen to build a research reactor for the Atomic Energy Research Institute of Japan. Westinghouse Electric Corp. has been selected by a Belgian private capital group to build an 11,500-kilowatt pressurized waterpower reactor to be in operation for the Belgian World's Fair in 1958. American Foreign Power Co. has under consideration the construction of three small power reactors with private capital in three South American countries. General Public Utilities Corp. has called for bids by July 1 on the building of a nuclear power station in Manila, Philippine Islands. These projects will also give substantial support to the atoms-for-peace program.

The contribution of military reactor development to civilian power

The Commission's military reactor development work is directed toward meeting specific requirements established by the Department of Defense. This work has nevertheless aided significantly in the development of technology for the civilian power program.

The reactor used in the *Nautilus* and its land prototype, for example, made important contributions to the technology of pressurized water reactors. The power reactors being developed by the Army for use at remote locations provide another illustration. Modifications of these reactors may be suitable for areas with high fuel costs and relatively small civilian power needs. The gas-cooled reactor, under consideration to meet Army needs for a system which would not be dependent on water, may prove particularly attractive for small central station powerplants.

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II. PRESSURIZED WATER REACTORS

Because of the relatively advanced state of technology of water-cooled reactors, the pressurized water concept was selected for the Shippingport, Pa., reactor—the only experimental reactor now under construction by the AEC as a part of a prototype fullscale powerplant. Experience with the Hanford reactors, the materials testing reactor, and the submarine thermal reactors has developed technical knowledge which is being applied in the pressurized water reactor.

Water has long been used in industrial and powerplant practice, its properties are relatively well known, and the cooling system is comparatively simple. In the pressurized water reactor the fuel rods containing fissionable material are surrounded by water under a pressure of about 2,000 pounds per square inch which serves both as a moderator and coolant. The water is heated by fuel elements and is pumped through a heat exchanger at about 500° F. where it gives up heat to form steam to operate a turbogenerator. The 2,000-pound pressure prevents boiling at the temperatures reached in the water surrounding the fuel elements at the hottest point.

Although it is expected that design improvements will bring powerplants using this type of reactor within a competitive range, it seems likely that other reactor concepts being developed will prove more economical in the long run. The cost of reactor pressure vessels (generally in excess of 9 feet in diameter) and the piping of the leak-resistant construction necessary with radioactive systems at high pressures is formidable.

Since it is an inherent characteristic of water that its vapor pressure increases rapidly with increasing temperature, high-pressure systems always will be necessary. It is unlikely that the high pressures required in such systems will ever permit the realization of power conversion efficiencies comparable to modern conventional steam plants. Further, the corrosive effect of high-temperature water makes necessary the use of materials that are very expensive or have poor neutron characteristics leading to relatively high fuel costs. Therefore, the Shippingport plant is not expected to produce economical power but, rather, to provide information that can only be obtained from the construction and operation of a prototype plant.

Shippingport project (PWR)

The nuclear portion of this plant is being designed and developed for the AEC by the Westinghouse Electric Corp. The Duquesne Light Co. of Pittsburgh is building the conventional portion of the plant and will operate the entire plant when it is complete. Duquesne is contributing $5 million toward the reactor construction cost, and Westinghouse is contributing $500,000.

Construction and testing of the steel structure to house the nuclear portion are underway by the Pittsburgh-Des Moines Steel Co. Erection of structural steel for the service and turbogenerator buildings began in March by the American bridge division, United States Steel. Pouring of all concrete is essentially complete.

The Dravo Corp., of Pittsburgh, was selected as reactor plant installation contractor under subcontract to Westinghouse. Shops and warehouses are completed, and actual work on installation of equipment foundations and some components has begun.

Construction of the reactor vessel, to contain the core of uranium fuel, is underway at the Chattanooga shops of Combustion Engineering Co. Portions of the steam generators, being built by the Babcock & Wilcox Co. and by Foster-Wheeler Corp., have been shipped to the site. Many smaller components are at the site ready for installation.

The PMR plant, estimated to be completed in 1957, will be the first large nuclear power generating station in the Nation. It will have a generating capacity of at least 60,000 electrical kilowatts.

Industrial projects

In addition to the Shippingport plant, whose reactor is largely Government financed, two industrial firms will build nuclear powerplants using pressurized water reactor concept—Yankee Atomic Electric Company of Boston and Consolidated Edison Company of New York. Yankee is proposing a 134,000-kilowatt plant to be built at Rowe, Mass., and to be completed in 1960. Negotiations with Yankee are in progress covering AEC assistance to the project. Consolidated has been issued a construction permit for a 140,000-kilowatt plant to be completed in 1960 (this plant will have a total electrical capacity of 250,000 kilowatts

including an oil-fired superheater). No AEC assistance for the consolidated project has been sought.

Further, in response to the Commission's Stepember 1955 public invitation to private industry to design, develop, construct, and operate small-scale power reactors, the University of Florida has submitted a proposal to build a pressurized water reactor of 500 kilowatts electrical capacity. This proposal is under consideration.

III. BOILING-WATER REACTORS

In the boiling-water reactor solid fuel elements and water moderation are employed as in the pressurized reactor. The basic difference between this plant and the PWR is that the water is permitted to boil, and steam from the reactor passes directly to the turbine. Variations of this type with an intermediate heat exchanger are possible.

Advantages of this concept are that the entire primary system may operate at a much lower pressure than in the PWR and a major piece of equipment (the intermediate heat exchanger) may be eliminated. With this arrangement, steam pressure and temperature at the turbine may be as high as in the reactor vessel itself.

This reactor has an inherent safety characteristic in that any power surge will increase steam formation and reduce the reactor power level. Unfortunately, this response is the opposite of that required in a nuclear powerplant to meet increased load requirements, and control problems are, accordingly, more complex.

The primary problems associated with this concept include demonstration of the nuclear stability and safety of a boiling reactor, development of a control system responsive to power demands, and evaluation of operating and maintenance problems in using radioactive steam in the turbine system.

Borax experiments

The Argone National Laboratory has been carrying forward developmental work on the boiling reactor concept since 1953 and has conducted low power reactor experiments identified as Borax I, Borax II, and Borax III at the National Reactor Testing Station.

Borax III ceased to operate in April because of a fuel element failure, after operating at NRTS for about 6 months at rated temperature and at electrical power levels up to about 2,000 kilowatts. A second core with new fuel elements is being developed and will be used in continuing the experiment as Borax IV. Initial operation is expected early in fiscal year 1957.

The Borax III experiment used the same reactor vessel as Borax II but incorporated a new core to produce greater thermal power. In addition, a 3,500-kilowatt turbine-generator was installed. This reactor became critical on June 9, 1955, and on July 17, 1955, the town of Arco, Idaho, was connected by transmission line to the Borax powerplant. For 1 hour and 5 minutes electricity exclusively from this plant was furnished to Arco.

The first reactor experiment in this series (Borax I) was operated at the National Reactor Testing Station in Idaho in 1953. Borax II was conducted during the winter of 1954–55 to study the steady State and transient charcteristics of a boiling reactor and to define the limits of stable operation as a function of variables such as pressure and specific power.

EBWR project

The phase in the boiling-water reactor program following the Borax III experiment is the construction and operation of the experimental boiling-water reactor (EBWR) at the Argonne National Laboratory. Fabrication of the containment shell to house the reactor has been completed and installation of major components is underway. The facility is expected to be generating power early in 1957.

The EBWR powerplant—designed to produce 20,000 kilowatts of heat and 5,000 kilowatts of electricity—is of the minimum capacity considered necessary to permit sound extrapolation to large size central station plants. Architect-engineer for the project is the Sargent & Lundy Co., of Chicago; the Sumner Sollitt Co. is constructing the reactor building under a lump-sum contract, and the turbine-generator, condenser, circulating water pumps, and associated equipment will be fabricated by the Allis-Chalmers Co. The Babcock & Wilcox Co. is constructing the reactor vessel, and the Grover Tank Co. has erected the steel containment shell.

Industrial participation projects

The Commonwealth Edison Co. and associates have received a construction permit for a full-scale plant of the boiling-water type with an electrical capacity

of 180,000 kilowatts. The Commission has received a proposal under the power demonstration reactor program from the Rural Cooperative Power Association of Elk River, Minn., to construct and operate an intermediate-sized plant also of the boiling-water type. This plant will have a nuclear electrical capacity of 15,000 kilowatts and a total electrical capacity of 22,000 kilowatts including an oil-fired superheater. Negotiations covering AEC assistance to the project are underway.

The General Electric Co. and the Pacific Gas & Electric Co. also notified the Commission in March of their decision to build and operate an atomic power-plant of the boiling-water type. A construction permit has been issued for this plant which will be located in Alameda County, Calif., and will be financed entirely by private capital. Plans call for its completion during 1957. Initially, it will have a generating capacity of 3,000 electrical kilowatts with an ultimate capacity of 10,000 kilowatts or more.

IV. SODIUM-COOLED REACTORS

A sodium-graphite reactor uses slightly enriched uranium as a fuel, graphite as a moderator, and liquid sodium as the coolant. Because of relatively high induced radioactivity in the liquid sodium that passes through the reactor, a second sodium loop has been added. Thus, the hazard of generating radioactive fumes from a chemical reaction if the sodium and water accidentally mix is eliminated.

Use of a liquid metal coolant permits the generation of steam in the heat exchanger at temperatures and pressures approaching those of modern conventional powerplants with only moderate pressure in the reactor tank. An additional advantage is the chemical compatibility of the materials used in the reactor.

The problems associated with this concept stem from the radioactivity of the reactor coolant which makes necessary the use of additional shielding, and an intermediate heat exchanger. Further, the structure of the core is fairly complex, requiring special attention in design and fabrication. Materials selection is also a serious problem. The technology associated with this concept is not as well advanced as that of the water reactors. With the experience that will come from operation of one or more of these plants, it may be possible to eliminate the intermediate heat exchanger simplify the core design, and reduce the tolerances that make the capital cost of this type of plant relatively high.

Sodium reactor experiment (SRE)

A sodium-cooled, graphite-moderated reactor experiment (SRE) is being undertaken for the Commission at Santa Susana near Los Angeles, Calif., by Atomics International, a division of North American Aviation, Inc. The reactor is rated at 20,000 kilowatts of heat. A contract is being negotiated under which this heat will be purchased by the Southern California Edison Co. at 45 cents per million B. t. u. and converted to electricity. The Edison Co. would provide the necessary boiler and turbogenerator, the latter rated at 7,500 kilowatts. Total cost of the reactor is $5,300,000. Atomics International is contributing $1,350,000 of this amount. In addition, the company will provide $1,500,000 toward the cost of the supporting development work, which will total $8 million for the 5-year period June 1953 to July 1958.

The reactor building is being completed, and many of the reactor facilities are being installed, including the intermediate heat exchangers, sodium pumps, sodium storage tanks, electrical components, and thermal shield cooling equipment. Fabrication of fuel elements is virtually completed.

Work has also progressed rapidly on the installation of electric generating facilities by the Southern California Edison Co. The turbogenerator, electrical switch gear, transformers, and large water-cooling tower are being installed. The steam generator is being fabricated by Babcock & Wilcox Co., and other sodium piping is being fabricated by Atomics International at the site.

Other phases of the work were delayed, and it is now anticipated that reactor fabrication will be completed by about October 1.

Reactor engineers and physicists are studying improved methods of reactor operation and startup procedures in anticipation of the critical tests to be started in January 1957.

Industrial projects

Consumers Public Power District of Nebraska is proposing to build near Lincoln, Nebr., a 75,000-kilowatt plant based on technology developed in the sodium reactor experiment. Negotiations are in progress covering AEC assistance to this project. The plant is expected to be completed in 1959.

The Chugach Electric Association, Inc., of Anchorage, Alaska, where power costs are high because of high fuel costs, has requested AEC assistance in a proposal under the second round of the power demonstration reactor program for a reactor that would combine desirable features of sodium-cooling and heavy-water moderation in one unit. This proposal is now under consideration. Use of the liquid metal would eliminate corrosion and pressurizing and make possible quite high temperatures. Heavy water would keep the fuel loading small, make for efficient use of neutrons, and simplify control.

It is necessary to have the incompatibles sodium and water, in the same reactor core to develop this concept being undertaken by Chugach's contractor, Nuclear Development Corporation of America. Slightly enriched uranium is specified for fuel and a 10,000-kilowatt plant is proposed.

V. FAST BREEDER REACTORS

A fast breeder reactor has the high-temperature, low-pressure characteristics of liquid-metal-cooled reactors and, in addition, permits breeding—that is, the production of more fissionable material than is consumed. This reactor does not use a moderator. The fuel core is concentrated and a blanket of natural or depleted uranium surrounds the fuel. Uranium 238 in the blanket will be transmuted into plutonium. Either enriched uranium or plutonium serves as fuel. Sodium is used as the coolant. Because the coolant becomes radioactive, an intermediate sodium heat exchanger is used to limit spread of radioactivity in the event of a leak in the boiler.

All the other reactors in this program are thermal, operating primarily with neutrons at energies of less than 1 electron volt. In contrast, the fast reactor operates with neutrons having energies of several hundred thousand electron volts. This leads to the most important advantage of fast reactors—the ability to convert non-fissionable uranium into fissionable plutonium more efficiently than thermal reactors. A program of critical experiments is underway to determine some of the basic nuclear characteristics of this type of reactor. The absence of moderator material and the need for highly concentrated fuel results in a core that is small in comparison with those of thermal reactors. Use of a small core imposes severe heat transfer problems.

Experimental breeder reactor EBR–1

The major effort on development of the fast breeder reactor concept is underway at the Argonne National Laboratory. Principal use of the first experimental breeder reactor (EBR–1), designed and operated by the laboratory at the National Reactor Testing Station, is to evaluate operational characteristics of this concept under various conditions. Accordingly, a series of investigations was planned to resolve the question of nuclear instability noted when the reactor was operating at low power. Although these planned experiments entailed a certain degree of risk because of the known positive temperature coefficient of the reactor they were considered to be valuable enough to the fast breeder program to be undertaken.

On November 29, 1955, one of the experiments resulted in a power increase which damaged the reactor. At that time information on the incident was incomplete and speculative, since the reactor was too radioactive to permit a proper inspection. Since then the radioactivity has decayed to a sufficiently low level to allow an examination of limited portions of the reactor. Available data indicate that the temperature at the core's center became high enough to melt the fuel.

The present plan is to remove the partially melted core by lifting out the center core structure into a temporary "hot cave" built on top of the reactor. This work is in progress. Examination of the sodium-potassium coolant in the reactor system reveals no measurable contamination by uranium or fission products. Upon replacement of the core structure with some modifications, the reactor will be ready for further use.

Shortly after the excursion occurred, radioactivity was noticed in the EBR–1 building and personnel were promptly evacuated. There was no significant exposure.

Experimental breeder reactor EBR–2

Preliminary design of the second experimental breeder reactor (EBR–2) at ANL has been completed and the architectural-engineering phase begun. The plant will be sodium-cooled, will generate 62.5 megawatts of heat, and produce 15,000 kilowatts or more of electricity. It is hoped that the reactor can be in operation in 1958, although there has been a delay in the EBR–2 schedule.

The zero power fast critical assembly (ZPR–III) operated successfully at NRTS during the first 5 months of 1956. This facility began operation in October 1955 and is being used to provide accurate data necessary for detailed design of the EBR–2 core. Critical experiments for the EBR–2 core with uranium 235 are continuing and a plutonium loading simulating the EBR–2 will be completed soon.

Because of the heavy workload imposed on ZPR–III, consideration is being given to the construction of another zero power fast critical assembly at the ANL site.

Molten plutonium reactor experiment

The molten plutonium fast reactor experiment at the Los Alamos Scientific Laboratory is still in the preliminary research and development phase. Because of the health precautions required in experimenting with molten plutonium, progress in this program is not expected to be rapid. Problems of containing molten plutonium are being investigated and samples have been prepared for irradiation in the materials testing reactor.

Industrial project

The sodium-cooled fast breeder atomic powerplant would be carried to the large-scale stage by the power demonstration reactor program proposal of the Power Reactor Development Co. (Detroit Edison Co. and others) for a 100,000-kilowatt installation, to be built at Monroe, Mich., and to be completed in 1960. Negotiations covering AEC assistance are in progress.

VI. AQUEOUS HOMOGENEOUS REACTORS

Aqueous homogeneous reactors use either solutions or suspensions of fuel in water. Fuel systems for such reactors in the present program involve uranium in either sulfuric- or phosphoric-acid solutions in either light or heavy water. By combining the fuel, moderator, and coolant in a single solution, the homogeneous reactor bypasses troublesome problems in the fabrication, corrosion, and stability of fuel elements. However, separate blanket solutions (or slurries) used in certain reactor types pose additional problems. This concept offers excellent control characteristics from both safety and power demand standpoints. Continuous chemical processing is a possibility, with new fuel being added and fission products being removed without shutting down the reactor.

As in the pressurized water reactor, the solution is kept under sufficient pressure to prevent boiling, and is pumped through heat exchangers where steam is produced. The possibility of continuous removal of fission products, many of which act as neutron absorbers, makes the reactor attractive as a breeder using uranium 235 as fuel and a thorium blanket as the fertile material. Heavy water surrounding the reactor core serves as a reflector. In a breeder reactor this would be replaced by a blanket of fertile material.

The aqueous homogeneous reactor, like a pressurized water reactor, needs high integrity pressure vessels and piping. The chemical solutions used in this reactor are very corrosive to most reactor materials and also exhibit a tendency to break down into undesirable forms under high radiation and temperature conditions.

Homogeneous reactor experiment

Oak Ridge National Laboratory is responsible for the major effort on aqueous homogeneous power reactors. To date one reactor experiment has been completed and the reactor dismantled in 1954, while another is in the preoperational testing stage. The one completed is the homegeneous reactor experiment No. 1 (HRE–1)—an embodiment of a concept proposed by the laboratory—which operated for 2 years there.

Operation of HRE–1 at full design power, with generation of about 150 kilowatts of useful electricity, was accomplished on February 24, 1953. It was the second reactor to generate electricity on an experimental basis. (The first electric power from nuclear energy was produced by EBR–1 in December 1951.) This first power reactor of its type circulated uranyl sulfate fuel solution at nearly 500° F. under a pressure of 1,000 pounds per square inch. It had a heat output of 1,000 kilowatts and a small turbogenerator.

HRE–1 was succeeded by the second homogeneous reactor experiment (HRE–2), whose construction was finished on April 21, 1956, in the same building at Oak Ridge that housed HRE–1. The reactor was started on a three-shift preoperational testing program on April 23. It is not expected to go critical for

6 months. Power output probably will not exceed 10,000 kilowatts of heat. Installation of an electrical generator is not now planned. Work on the associated chemical processing plant is progressing.

Overall evaluation of the aqueous homogeneous concept has shown that it holds promise for economic power production, and experimental work has indicated the solution to many of the technical problems.

Los Alamos power reactor experiments

Besides the program at Oak Ridge, the Los Alamos Scientific Laboratory is studying homogeneous reactors using uranyl phosphate solutions. The phosphate solutions should permit higher temperature operation than is possible with the sulfate solutions. However, the higher temperatures aggravate the corrosion problems. Because of its compactness, this type of reactor offers promise as an energy source for small powerplants for remote locations.

At the Los Alamos Scientific Laboratory construction of the Los Alamos Power Reactor Experiment No. 1 (LAPRE No. 1) has been completed. Tests were initiated, but because of mechanical damage occurring to cladding in the bottom portion of the reactor, apparently during final assembly, it was necessary to shut down the reactor and make repairs.

LAPRE No. 1 is equipped with a fuel circulating pump and is designed to generate fairly high pressure steam and have a thermal output of 2 megawatts. The other experimental power reactor in the LASL program, LAPRE No. 2, depends upon natural convection to circulate the fuel and is designed to produce a lower pressure steam with a thermal output of 1.3 megawatts. All of its components are fabricated and are being assembled.

Both of these power reactor experiments are expected to be critical in 1956. The cylindrical pressure vessels contain not only the fuel solutions but also the heat exchangers or boilers for the generation of steam. In this way circulation of the highly radioactive fuel solutions outside the pressure vessels is avoided.

Industrial projects

The Pennsylvania Power & Light Co. has announced plans to build a plant of about 150,000 kilowatts electrical capacity using a homogeneous reactor with Westinghouse Electric Co. doing the development work. A firm decision to proceed will not be reached until 1958. Completion is expected in 1962. No assistance from AEC has been requested, although the AEC's extensive program in aqueous homogeneous reactors is contributing knowledge of substantial benefit to this project.

In response to AEC's September 1955 public invitation to private industry to design, develop, construct, and operate small-scale power reactors with capacities ranging from 5,000 to 40,000 kilowatts, Wolverine Electric Cooperative, Big Rapids, Mich.) has submitted a proposal to build a 10,000-kilowatt plant, using an aqueous homogeneous reactor. Heat from the reactor will be supplemented by an oil-fired superheater. Negotiations on AEC assistance are in progress.

VII. OTHER REACTOR CONCEPTS

Organic-moderated reactors

Organic compounds have several potential advantages as moderator-coolants: low-induced radioactivity, low corrosion of fuel elements, and higher temperatures at lower pressures than would be possible with water. The organic moderator-coolant absorbs heat as it circulates around the fuel elements and then is pumped through a heat exchanger.

In April the Commission signed a contract with Atomics International, a division of North American Aviation, Inc., for the construction and operation of an organic-moderated reactor experiment (OMRE) to be conducted at the National Reactor Testing Station. Estimated cost of the initial phase of the experiment is $1.8 million, of which approximately $750,000 will be borne by the company.

The experiment is designed to establish the technical feasibility of diphenyl or other hydrocarbons as reactor moderating and cooling materials. The experiment will simulate conditions of heat transfer, temperature, and coolant flow which would exist in a practical power reactor.

The OMRE will be designed to generate 5,000 to 15,000 kilowatts of heat and will use fuel elements highly enriched in uranium 235. Construction will begin this year and the reactor is expected to begin operating early in 1957.

In addition to the OMRE, the city of Piqua (Ohio), under AEC's power demonstration reactor program, has proposed a terphenyl moderated and cooled

reactor plant to produce 12,500 kilowatts of electricity. This proposal is under consideration. The tentative design prepared by Atomics International for Piqua calls for a pressure of 35 pounds per square inch to be held on the terphenyl, at which pressure this coolant has a boiling point of 850° F. A small amount will be constantly purified and continuously returned to the reactor in much the same way that the oil of an automobile engine is filtered continuously. New terphenyl will have to be added to make up for the material that is decomposed. The current market price of this liquid is about 17 cents a gallon.

Liquid metal-fuel reactors

A liquid metal fuel reactor would combine most of the advantages of the aqueous homogenous and liquid-metal-cooled types. Using molten metal as a carrier of uranium, it would operate at high temperatures and relatively low pressures. The temperatures may be high enough to allow steam conditions comparable to those in modern conventional generating plants. The reactor uses molten uranium-bismuth as a fuel and graphite as a moderator. The molten fuel is pumped through the heat exchanger where heat is removed.

The Commission has begun negotiations with the Babcock & Wilcox Co. for the development, design, fabrication, and operation of a liquid metal-fuel reactor experiment (LMFRE). The Union Carbide Nuclear Co. will subcontract the chemical engineering phases of the work. The Babcock & Wilcox proposal was selected as the best of 11 submitted to AEC as a result of the Commission's expressed interest in this reactor concept.

The liquid metal-fuel reactor experiment will carry forward research work done for the Commission by the Brookhaven National Laboratory. The laboratory will continue to contribute substantially to general LMFR development, while Babcock & Wilcox will concentrate on the engineering aspects of the experiment.

The Orlando Utilities Commission (Orlando, Fla.) has proposed under the power demonstration reactor program the development and construction of a reactor of this type to produce 25,000 to 40,000 kilowatts of electricity. The proposal is under consideration.

The liquid metal-fuel concept appears to offer considerable promise as an economic source of heat for central station powerplants. In addition, its nuclear flexibility is such that it can operate as a thermal, intermediate, or fast reactor in a variety of sizes. The present experiment will be designed to establish basic technical feasibility of the concept rather than to serve as a pilot-plant demonstration of a particular LMFR design concept. This experiment will carry a seventh reactor approach to power into the reactor fabrication stage.

Gas-cooled reactors

A gas-cooled reactor is attractive if it can be coupled directly to a turbine. With gas temperatures of 1,400° F. or higher, it is possible to attain good efficiency without a heat exchanger or steam boiler. By use of an inert gas, corrosion of fuel elements may be minimized.

Studies of gas-cooled reactor systems have been directed toward determining whether such systems will meet needs for both small central stations and mobile nuclear powerplants—the latter especially for military use. The principal problem to be overcome in developing a gas-cooled reactor power plant which would be economically competitive is the design of fuel elements with a reasonable life expectancy at the high temperatures needed for good thermal efficiency.

Study contracts have been negotiated with the Ford Instrument Co. and the Studebaker-Packard Corp. to provide a better understanding of the potential economics of this concept and to delineate the research and development remaining to be accomplished. Research and development on suitable materials is being sponsored by the Army Reactors Branch of the Commission's Division of Reactor Development. Battelle Memorial Institute has begun testing materials applicable to this reactor concept, and a contractor is being selected to design, construct, and operate a gas-cooled reactor experiment.

Under the Commission's power demonstration reactor program, the city of Holyoke, Mass., has proposed a 15,000-kilowatt gas turbine nuclear plant to be built by Ford Instrument Co. in which the heat source would be a reactor cooled by passing nitrogen directly through the core. This proposal is under consideration.

Plutonium recycle test reactor

The Commission has requested the General Electric Co. at Hanford to submit plans for a research and development program covering the use of plutonium in

the operation of thermal heterogeneous power reactors. The recycling of plutonium as fuel in these reactors has three important merits: (*a*) It may reduce fuel costs, (*b*) it will net more power from a given uranium supply, and (*c*) it will increase the usefulness of reactors in other countries requiring slightly enriched uranium by reducing the dependence of such reactors on isotope-separation plants.

Very little research and development work on the use of plutonium for this particular application has been done. The work planned will include reactor physics, reactor engineering, and metallurgical aspects of plutonium recycling.

Development of improved uranium fuel elements and other advanced reactor technology will also be objectives of this Hanford program, and construction of a small experimental reactor is contemplated as the focal point of the program.

Scientists and engineers at the Hanford plant have had considerable experience in these fields in connection with their work on the Hanford production reactors. Undertaking the work at that installation will utilize their skills (along with the extensive development facilities available there) to the fullest possible extent.

VIII. ENGINEERING DEVELOPMENT

In addition to the specific reactor projects which are underway, a general engineering development program is being carried out. This program covers the development of all components which are an integral part of the reactor complex. It is here that new concepts are evaluated; reactor physics data are investigated and compiled; new and better fuel elements are developed and fabricated; reactor materials and alloys for reflectors, moderators, control rods, and other structural materials are developed; reactor coolants and heat transfer characteristics are studied; and problems related to electric power generation are investigated. In addition, instrumentation, control, shielding, and safety characteristics are under study.

Greater emphasis has been placed on the reactor safety program than on any other. Transient tests are being conducted on both homogeneous and heterogeneous reactors to determine their safe upper and lower operating levels. In further support of the reactor safety program, investigations of fuse mechanisms, metal-water reactions, the kinetics of the ignition of reactor metals and others are being undertaken. Safety work is necessary in the future on fast reactor systems and on reactor systems using low enrichment uranium fuel and either graphite or water moderated.

General reactor development work in the future will emphasize higher temperatures and higher fluxes than have heretofore been considered.

Another phase of the general development work is separations systems development. This work is in direct support of the civilian power program and the military reactor programs. It is in this program that chemical processing technology and waste-disposal methods are developed for the many varieties of fuels used in reactors. The present studies in chemical processing are aimed at developing better aqueous and pyrometallurgical systems for processing both heterogeneous and homogeneous fuels. Increased emphasis is being placed in determining safer and more economical methods of disposing of high- and low-level wastes to the environment. In addition the Commission is developing and encouraging industry to devise means of utilizing fission products and spent fuel elements in industrial applications.

As chemical processing represents an important portion of power costs, perhaps 1 mill per kilowatt-hour for the heterogeneous systems, vigorous efforts must be continually pursued to develop better processing. These programs are being accelerated to keep pace with the reactor projects underway.

CHART 1

Developing civilian atomic power

Type of reactor	Government's experimental program	Power demonstration program	Independent industrial program
Pressurized water	Shippingport, Pa.: Duquesne Light Co. and Westinghouse Electric Corp. for AEC, 60,000 kilowatts, 1957.	Rowe, Mass.: Yankee Atomic Electric Co., 134,000 kilowatts, 1960; University of Florida (Gainesville) 500 kilowatts, 1959.	Indian Point, N. Y.: Consolidated Edison Co. of New York, 140,000 kilowatts, 1960.
Boiling water	Lemont, Ill.: Experimental boiling water reactor: Argonne National Laboratory, 5,000 kilowatts, 1957.	Elk River, Minn.: Rural Cooperative Power Association, 22,000 kilowatts, 1960.	Dresden, Ill.: Nuclear Power Group (Commonwealth Edison Co. and others, 180,000 kilowatts, 1960; Livermore, Calif.: General Electric Co. and Pacific Gas & Electric Co., 3,000 kilowatts, 1957.
Sodium cooled:			
Thermal	Santa Susana, Calif.: Sodium reactor experiment, North American Aviation for AEC and Southern California Edison Co.[1] 7,500 kilowatts, 1957.	Consumers Public Power District (Nebraska): 75,000 kilowatts, 1959; Anchorage, Alaska: Chugach Electric Association, Inc., and Nuclear Development Corporation of America, 10,000 kilowatts, 1962.	
Fast	National Reactor Testing Station: Experimental breeder reactor No. 2. Argonne National Laboratory, 17,500 kilowatts, 1959; Los Alamos Scientific Laboratory: Molten ten plutonium reactor experiment, no electricity, 1959.	Monroe, Mich.: Power Reactor Development Co., Inc., Detroit Edison Co., and others, 100,000 kilowatts, 1960.	
Fluidized:			
Aqueous homogeneous.	Oak Ridge National Laboratory: Homogeneous reactor experiment No. 2 No electricity, 1956; Los Alamos Scientific Laboratory, power reactor experiments Nos. 1 and 2: No electricity, 1956.	Hersey, Mich. Wolverine Electric Cooperative, 10,000 kilowatts, 1959.	Eastern Pennsylvania: Pennsylvania Power & Light Co., 150,000 kilowatts, 1962.
Liquid metal	Liquid metal-fueled reactor: The Babcock & Wilcox Co., 1959.	City of Orlando, Fla.: 25,000 to 40,000 kilowatts, 1961.	
Organic moderated	National Reactor Testing Station: Organic moderated reactor experiment, North American Aviation for AEC, no electricity, 1957.	City of Piqua, Ohio: 12,500 kilowatts, 1961.	
Gas cooled	Gas-cooled reactor (contractor not selected).	City of Holyoke, Mass.: 15,000 kilowatts, 1961.	
Unspecified			Florida: Florida Power Corp., Florida Power & Light Co., Tampa Electric Co., 200,000 kilowatts, 1962.

[1] Turbogenerator and other conventinal electric transmission equipment.

NOTE.—Dates shown are for start of operation.

ESTIMATED PROGRAM TOTALS

Costs:	
Estimated cost of all work from July 1, 1953, through completion of projects listed, includes cost of core fabrication but excludes cost of special nuclear materials. Excludes EBR–1, HRE–1, and Borax–1, 2, and 3:	
Government	$236, 000, 000
Industry	20, 000, 000
Based on proposals submitted to AEC. Excludes cost of core fabrication and of special nuclear materials:	
Government	77, 000, 000
Industry	128, 000, 000
Based in part on statements made by sponsoring utilities and in part on AEC estimates:	
Government	0
Industry	210, 000, 000
	Kilowatts
Total electrical capacity	1, 182, 000
Government's experimental program	90, 000
Power demonstration program	419, 000
Independent industrial program	673, 000
Total estimated cost	$671, 000, 000
Government	313, 000, 000
Industry	358, 000, 000

TABLE I.—*Summary of major power reactor experiments—Pt. 1*

	EBR No. 1	EBR No. 2	HRE No. 1	HRE No. 2	Borax III	EBWR	SRE
Location	NRTS, Idaho		Oak Ridge	Oak Ridge	NRTS, Idaho	Argonne	Santa Susana, Calif.
Responsible laboratory	Argonne	Argonne	do	do	Argonne	do	Atomics International (NAA, Inc.).
Heat output	1,400 kilowatts	62,500 kilowatts	1,000 kilowatts	5,220 kilowatts	15,000 kilowatts	20,000 kilowatts	21,000 kilowatts.
Generating capacity	150 kilowatts	17,500 kilowatts	150 kilowatts	300 kilowatts	2,400 kilowatts	5,000 kilowatts	7,500 kilowatts.
Cost of reactor [1]	$2,700,000	$15,280,000 [2]	$1,100,000	$4,500,000 [3]	$600,000 [4]	$3,600,000 [4]	$4,700,000.
Total cost	$6,000,000	$36,600,000 [2]	$12,800,000	$39,800,000 [3]	$2,800,000 [4]	$20,700,000 [4]	$14,450,000. [5]
Start of construction	1949 (fall)	1957	1950	1954 (July)	1954 (September)	1955 (June)	1955 (April).
Reactor critical	1951 (August)	1959	1952 (April)	1956	1955 (June)	1956	1956.
Date operation at full power	1951 (December)	do	1953 (February)	do	1955 (July)	1957	1957.
Reactor outlet temperature	600° F	900° F	482° F	572° F	417° F	488° F	960° F.
Reactor pressure	15 p. s. i. g	50 p. s. i. g	1,000 p. s. i. g	2,000 p. s. i. g	300 p. s. i. g	600 p. s. i. g	3 p. s. i. g.
Amount uranium fuel	52 kilograms	200 kilograms	2 kilograms	5.2 kilograms	15 kilograms	4,500 kilograms	2,100 kilograms.
Enrichment, U-235	About 90 percent	60 percent	About 90 percent	About 90 percent	About 90 percent	1.4 percent	2.8 percent.
Moderator	None	None	H_2O	D_2O	H_2O	H_2O	Graphite.
Coolant	Sodium-potassium.	Sodium	Circulating fuel solution.	Circulating fuel solution.	H_2O	H_2O	Sodium.
Control method	Movable blanket and U-238 rods.	Movable blanket and fuel rods.	U con. and temperature coefficient.	U conc. and temperature coefficient.	Control rods and chemical solution.	Control rods	Control rods.
Steam conditions	400 p. s. i. g., 525° F.	1,250 p. s. i. g., 850° F.	200 p. s. i. a., saturated.	520 p. s. i. a., saturated.	300 p. s. i. g., saturated.	600 p. s. i. g., saturated.	600 p. s. i. g., 825° F.

[1] Includes building to house reactor and fabrication of fuel elements for 1st charge but not fissionable material.
[2] Estimate through fiscal year 1958 only.
[3] Includes modification to higher power. Estimate through fiscal year 1958 only.
[4] Borax III costs also included in EBWR costs.
[5] Includes turbogenerator furnished by Southern California Edison Co.

TABLE I.—*Summary of major power reactor experiments—Pt. 2*

	LAPRE I	LAPRE II	LAMPRE	OMRE	LMFRE
Location	Los Alamos	Los Alamos	Los Alamos	NRTS, Idaho	
Responsible laboratory	do	do	do	Atomics International (NAA, Inc.).	Brookhaven.
Heat output	2,000 kilowatts	1,000 kilowatts	About 1,000 kilowatts	16,000 kilowatts	5,000 to 10,000 kilowatts.
Generating Capacity	None	None	None	None	None.
Cost of reactor [1]	$700,000 [2]	$100,000 [2]	Not available	$875,000	$8,000,000.
Total cost	$2,300,000 [2]	$280,000 [2]	$3,000,000	$1,900,000	$25,000,000.
Start of construction	1954	1955	1956	1956	Not available.
Reactor critical	1956	1956	1959	1957	Do.
Date operation at full power	do	do	do	do	1960.
Reactor outlet temperature	800° F	600° F	Not available	530° F	Not available.
Reactor pressure	About 3,900 p. s. i. g	About 800 p. s. i. g	do	300 p. s. i. g	Do.
Amount uranium fuel	4.25 kilograms	3.85 kilograms	Molten plutonium alloy	20 kilograms	Do.
Enrichment, U-235	About 90 percent	About 90 percent	Not available	About 90 percent	Do.
Moderator	H_2O	H_2O	None	Diphenyl	Graphite.
Coolant	H_2O	H_2O	Sodium potassium	do	Circulating fuel solution in bismuth.
Control method	Solution volume, temperature coefficient, and control rods.	Solution volume, temper- coefficient, movable reflector.	Movable reflector	Control rods	U conc., temperature coefficient, control rods.
Steam conditions	3,600 p. s. i. a	600 p. s. i. a., saturated	None	None	None.

[1] Includes building to house reactor and fabrication of fuel elements for 1st charge but not fissionable material.

[2] Estimate through fiscal year 1957 only.

TABLE II.—*Summary of large prototype power reactor plants proposed—Pt. 1: Power demonstration reactor program projects and others*

Company	Westinghouse and Duquesne Light Co.[1]	Yankee Atomic Electric Co.	Consolidated Edison Co.	Commonwealth Edison and others	Consumers Public Power District	Power Reactor Development Co. (Detroit Edison et al.)	Westinghouse and Pennsylvania Power & Light
Location	Shippingport, Pa.	Rowe, Mass.	Indian Point, N. Y.	Dresden, Ill.	Hellum, Nebr.	Monroe, Mich.	Pennsylvania Power & Light service area.
Type of reactor	Pressurized water (PWR).	Pressurized water.	Pressurized water.	Boiling water.	Sodium graphite.	Fast breeder.	Homogeneous.
Thermal power	236,000 kilowatts.	480,000 kilowatts.	500,000 kilowatts.	682,000 kilowatts.	250,000 kilowatts.	300,000 kilowatts.	Not available.
Gross generating capacity	100,000 kilowatts.	134,000 kilowatts.	250,000 kilowatts [2].	180,000 kilowatts.	75,000 kilowatts.	100,000 kilowatts.	150,000 kilowatts.
Amount of fuel	12 T natural U and 52 kilograms about 90 percent.	28,800 kilograms.	275 kilograms U and 8,100 kilograms Th.	68,000 kilograms.	24,600 kilograms.	2,100 kilograms.	Not available.
Enrichment percent U-235		2.5 percent.	About 90 percent for U.	1.1 percent.	1.8 percent.	27 percent.	Do.
Moderator	H_2O	H_2O	H_2O	H_2O	Graphite.	None.	Do.
Coolant	H_2O	H_2O	H_2O	H_2O	Sodium.	Sodium.	Fuel solution.
Reactor temperature [3]	540° F.	535° F.	500° F.	480° F.	925° F.	800° F.	Not available.
Reactor pressure	2,000 p. s. i. g.	2,000 p. s. i. g.	1,500 p. s. i. g.	600 p. s. i. g.	3 p. s. i. g.	100 to 200 p. s. i. g.	Do.
Steam conditions	585 p. s. i. g., saturated.	600 p. s. i. a., saturated.	420 p. s. i. a., saturated.	600 p. s. i. a., 480° F.	800 p. s. i. g., 825° F.	600 p. s. i. a., 720° F.	600 p. s. i. a.
Estimated cost of reactor [4]	$37,750,000.	$18,500,000.	Not available.	$34,200,000.	$13,500,000.	$36,000,000.	Not available.
Estimated cost of turbogenerator plant.	$10,000,000.	$16,000,000.	do.	$10,800,000.	$10,800,000.	$9,000,000.	Do.
Total estimated plant cost	$47,750,000.	$34,500,000.	$55,000,000.	$45,000,000.	$24,300,000.	$45,000,000.	Do.
Cost per kilowatt	$370.	$246.	$230.	$250.	$320.	$540.	Do.
Estimated completion date	1957.	1959–60.	1960.	1960.	1959.	1960.	1962.

[1] This reactor is being built by the AEC; Westinghouse and Duquesne are prime contractors to the AEC.
[2] Includes 110,000 kilowatts of conventional superheating capacity.
[3] Average temperature of coolant in reactor.
[4] Not including research and development, fabrication of fuel elements for 1st charge, or nuclear materials. Fuel element fabrication and nuclear materials are included in fuel costs.

TABLE II.—*Summary of small prototype power reactor plants proposed—Pt. 2: Power demonstration reactor program*

	Chugach Electric Association	Wolverine Electric Cooperative	University of Florida	City of Orlando, Fla.	Rural Cooperative Power Association	City of Piqua, Ohio	City of Holyoke, Mass.
Location	Anchorage, Alaska.	Hersey, Mich.	Gainesville, Fla.	Orlando, Fla.	Elk River, Minn.	Piqua, Ohio.	Holyoke, Mass.
Type of reactor	Sodium-cooled heavy-water moderated.	Aqueous homogeneous.	Pressurized water.	Liquid metal fuel Th. Br. blanket.	Boiling water.	Organic moderated.	Gas-cooled closed cycle.
Thermal power	40,000 kilowatts.	31,000 kilowatts [1].	10,000 kilowatts.	Not available.	58,000 kilowatts.	45,500 kilowatts.	44,000 kilowatts.
Gross electrical generating capacity	10,000 kilowatts.	10,000 kilowatts.	500 kilowatts.	25,000 to 40,000 kilowatts.	22,000 kilowatts.	12,500 kilowatts.	15,000 kilowatts.
Amount of fuel per loading	10,000 kilograms uranium.	12 kilograms.	Not specified.	60 kilograms U-235, 17,000 pounds Th.	12 kilograms enriched, 10,000 kilograms normal.	6,300 kilograms.	70 kilograms.
Enrichment, percent U-235	Approximately 2 percent.	Fully enriched.	30 to 40 percent.	Fully enriched.	Fully enriched, spikes, natural uranium core.	3 percent.	5 percent.
Moderator	Heavy water.	Uranyl sulfate in heavy water.	H_2O.	Graphite.	H_2O.	Hydrocarbon.	Graphite.
Coolant	Liquid sodium.		H_2O.	U-235 in molten bismuth solution.	H_2O.	do.	Nitrogen gas.
Reactor temperature [2]	950° F.	570° F.	450° F.	Not specified.	533° F.	617° F.	1,292° F. [3]
Reactor pressure	Atmospheric.	1,900 p. s. i. g.	1,200 p. s. i. g.	do.	900 p. s. i. g.	30 p. s. i. g.	515.7 p. s. i. a.
Steam conditions	850 p. s. i. g., 850° F.	600 p. s. i. a., [4] 486° F.	200 p. s. i. g., 407° F.	1,250 p. s. i. g., 900° F.	600 p. s. i. g., 825° F.	410 p. s. i. g., 550° F.	Not specified.
Estimated cost of reactor [5]	$5,500,000 [6]	$2,486,000.	$650,000.	$12,500,000.	$3,760,000.	$3,340,000.	$2,400,000.
Estimated cost of turbo-generator plant.	$1,850,000.	$1,088,000.	$1,200,000 [7].	$11,100,000.	$2,425,000.	$1,960,000.	$4,028,000.
Total estimated plant cost	$7,350,000.	$3,574,000.	$1,850,000 [8].	$23,600,000.	$6,185,000.	$5,300,000.	$6,428,000.
Cost per kilowatt	$735.	$357.	$800.	$512 to $820.	$281.	$424.	$429.
Estimated completion date	1962.	1960.	1959.	1960.	1960.	1960.	1960.

[1] Includes superheater, 7,000 kilowatt thermal.
[2] Average temperature in reactor.
[3] Maximum gas temperature at the reactor outlet or turbine inlet.
[4] Steam from heat exchanger to gas-fired superheater which delivers steam at 565 p. s. i. a. t 825° F.
[5] Does not include research and development.
[6] Does not include design cost.
[7] Does not include building cost.
[8] Subject to change.

Mr. DAVIS. It has been stated many times that the technical feasibility of nuclear power has been established by operation of power producing reactors of several widely different concepts. It has also been emphasized that there has not been a demonstration of producing nuclear power economically competitive with other means of producing power under comparable conditions.

There have been various estimates or forecasts of decreasing costs of nuclear power and increasing nuclear power capacity. These forecasts are believed to have reasonable validity inasmuch as they are based principally on extrapolation of engineering developments and are not particularly dependent upon new discoveries or inventions. The long range growth of the nuclear power industry will, of course, depend upon actual results of the development program and the relative economics of nuclear power as it is influenced by new technology, governmental regulations and other factors.

The effectiveness of any program is likely to be improved if the objectives are stated in terms of what appear to be optimistically attainable time schedules. In the case of the civilian power reactor program we have short-range objectives and long-range objectives. We have indicated in the past that some of the reactor concepts under development are primarily of short-range interest because they can be built sooner, even though they do not seem to have as great long-term promise as other concepts. Similarly some concepts require very intensive, expensive, and time-consuming research and development effort, but this is justifiable by the long-term promise which the systems appear to have.

Naturally, there are graduations all along the line and various concepts cannot really be evaluated on an absolute scale either as to promise or required development. Also, there are many different conditions, including such factors as power requirements, geography, and available materials, the consideration of which will result in variations in relative evaluations of different reactor concepts for different uses.

In a general sense, however, the short-range objective of the civilian power reactor programs is to maintain the leadership of the United States in the development of reactor technology and to provide for the construction and operation of power reactors which may be of immediate interest to other countries less favorably situated with regard to availability and cost of other energy resources. The long-range objective of the program is to provide relatively low-cost nuclear power for the United States as well as other friendly foreign countries.

The current status of technology may be discussed in terms of progress with specific design concepts or in terms of the overall program objective of achieving economically competitive nuclear power in the United States and abroad. Consider the situation first with respect to specific design concepts.

The development of a particular reactor from its earliest beginning through commercial utilization falls into a number of phases which can be defined in a general way, although there is some degree of overlap which depends not only on the reactor concept, but on the method and urgency of the development. Thus, in any orderly development program one might expect to find the following phases:

1. Exploratory phase, in which very preliminary work on fuel and other component materials is carried out and conceptual design studies are made, including reactor physics and engineering characteristics.

2. Developmental phase, in which conceptual ideas are tested on an expanded experimental basis and more detailed studies are made of fuel element design, control problems, heat transfer, and fluid mechanic problems.

3. Reactor experiment phase, in which design and construction of an operating reactor is undertaken to provide technological data on all basic questions, including performance of fuel elements, behavior of control systems, safety, and other physics and engineering characteristics.

4. Prototype phase, in which design and construction of prototype power reactors are undertaken with the aim of producing power on a continuing basis and to gain information on construction problems, operating problems, and unit costs.

5. Commercial phase, in which reactors are built as economically competitive powerplants.

Chairman ANDERSON. Would you give some estimate of how long it would have taken to build the first atomic bomb if we had gone through all of these phases?

Mr. DAVIS. I am afraid that is some way out of my line.

Chairman ANDERSON. Could we have made it in 100 years?

Mr. DAVIS. I believe, in effect, the first atomic bomb went through essentially the same phases.

Chairman ANDERSON. I do not understand what the scientists tell me when they say they did it with quantum jumps. They would try out some test but at the same time go beyond that test and go on to the next step.

Mr. DAVIS. They certainly had an exploratory phase where they considered the possibility of building a bomb, itself, the development phase in which they tested out various ideas, and they certainly had an experiment phase.

Certainly they have gone through prototype phases, and I do not know whether you call the present phase a commercial phase or not.

Chairman ANDERSON. I have been going through some records of the first week-long series of meetings up at the ranch, which later became Los Alamos.

Mr. DAVIS. I would say that was the exploratory phase at that time.

Mr. STRAUSS. It took from late 1941 until July of 1945.

Representative HINSHAW. To demonstrate something that had never been demonstrated before.

Representative VAN ZANDT. It was a model in comparison to what we have today.

Chairman ANDERSON. It would never have been done in that period if they had stopped to consider every possibility and test all of them out and see which was the most economical way to do it, and then take the next step and go on to that, I am afraid.

Mr. DAVIS. They did not have an economic goal to try to meet, either.

Mr. STRAUSS. There was a war and cost was no object.

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Chairman ANDERSON. That is right, and there are those that think that we are to some degree in the contest over atomic power. It could be that we are not. I am just wondering. I am wondering if it would take a little longer to go through these steps.

Mr. DAVIS. What we are attempting to point out here is that there are a series of stages through almost any new scientific or engineering principle. It goes through those in its development prior to its application.

It should be clear that the number of reactor concepts under investigation diminishes as one proceeds through these development phases and that the decision to proceed to subsequent phases in each project is made in the light of the expected performance of that concept in relation to others expected to be available at comparable stages of development at about the same time.

At the present time no concepts have reached the commercial phase and only one prototype reactor—the pressurized water reactor at Shippingport, Pa.—is actually under construction. Plans are reasonably firm for 7 other prototype reactors, including 5 large-scale: Yankee Atomic Electric, Consolidated Edison, Commonwealth Edison, Comsumers Public Power District of Nebraska, and Power Reactor Development Co.; and 2 small-scale: Rural Cooperative Power Associates of Elk River and Wolverine Rural Cooperative. These plants should be completed by 1960 or 1961 if the plans go into effect.

Chairman ANDERSON. Is there any actual contractual obligation to have these plants ready by 1960 or 1961?

Mr. DAVIS. Well, these people, to the extent they are in the power demonstration program, are entering into contracts with us which have not yet been signed, which will put upon them some obligations to proceed with their projects. In the cases of some of the independent industrial companies, they have entered into contracts with the equipment manufacturers to do research and development work and preliminary work in the construction of their plants. There are certainly now or contemplated contractual obligations either with the Commisssion or between various parts of industry which make these projects seem quite realistic.

Chairman ANDERSON. Well, let us take them one by one. Do you think the Yankee Atomic Electric is sufficiently gauranteed so that it will be in completion by 1960 or 1961?

Mr. DAVIS. Well, I certainly have every confidence it will be. We have not yet signed a contract with Yankee. We have one in draft which I believe is in pretty good shape. They have a contract being worked out with Westinghouse which is a two-way contractual obligation there. These contracts are signed, and they are under contractual obligation to go ahead with Westinghouse and with ourselves.

Chairman ANDERSON. What about the Consumers Public Power District of Nebraska?

Mr. DAVIS. Consumers, again, is a three-way contractual deal, with North American on the one hand as equipment suppliers, and with ourselves on the other hand under the demonstration program. Again we are in the later stages of the contract negotiation on this. This contract will certainly carry some obligations for them to proceed.

Chairman ANDERSON. Will there be any problem on financing as you see it, at the present time?

Mr. DAVIS. On financing of Consumers, you mean?

Chairman ANDERSON. Yes.

Mr. DAVIS. No; not that I know of. Certainly North American is going ahead with their end of the development work. They are prepared to back up the proposal.

Chairman ANDERSON. Well, I simply call your attention to your own language, that these plants should be completed in 1960 or 1961 if the plans go into effect.

Mr. DAVIS. I probably should add that we fully expect that they will.

Chairman ANDERSON. All right. Will you proceed.

Mr. DAVIS. Other project proposals have been submitted for Commission consideration, 5 small-scale reactors under second round PDRP, or have been announced as planned for financing without Commission assistance, Pennsylvania Power & Light, and Florida Utilities, but these are more indefinite as to concept or schedule at the present time. Those with reasonably firm plans encompass five different concepts—pressurized water, boiling water, sodium-graphite, fast breeder, and single region homogeneous. However, there will be significant operating experience with only one large-scale prototype plant before 1960, the pressurized water concept.

Chairman ANDERSON. Now, there is some difference between the Shippingport situation where the Atomic Energy Commission is in position to push these people if it wishes to, and these others where you have no authority whatever to push them. Do you really have any power? I do not say that you should have it, but do you have any control over how rapidly they move ahead?

Mr. DAVIS. There is one general type of control, which is in the licensing where they get a construction permit. They are obliging themselves to complete the construction within a certain period of time. That is usually spelled out in the license.

Chairman ANDERSON. But does it carry any penalty provisions?

Mr. DAVIS. Presumably their later license is contingent upon their completing the construction during this time period. I think it is quite likely that if they ask for an extension——

Chairman ANDERSON. Their license is contingent upon their completing it in a time period?

Mr. DAVIS. This license is only valid for the period for which it is granted. They would have to come to us to get an extension.

Chairman ANDERSON. Is there a time limit in the license?

Mr. DAVIS. In the construction permit there is a time limit.

Chairman ANDERSON. Is it a construction license or permit?

Mr. DAVIS. It is a license. Mr. Price can speak to this, but it is my understanding that they specify the time period during which they will complete the construction of the plant if the license is granted on this basis.

Chairman ANDERSON. But it could be extended, could it not?

Mr. DAVIS. It could be extended by the Commission if the Commission desired to extend it.

Chairman ANDERSON. There is no penalty whatever?

Mr. DAVIS. No penalty. There might be considered to be some risk, I would think.

Chairman ANDERSON. I am just trying to find out if there is any way by which you could, and I am not trying to say it should be in

the contract because it should not. These people are investing their own money and they must have a right to do it, but I am trying to find out if there is any compulsion to compel them or to require them to be through with their construction work and have a plant ready to operate by any specified date.

Mr. DAVIS. Our contracts under the power demonstration program generally would be of such a nature that they would require performance of the research and development phases around which they are written, but there again, although they spell out the project, they would essentially not have any penalties if they did not complete the project in time. But certainly by the time that they had invested this much money in the project, we feel quite certain they would not drop it at that point.

Chairman ANDERSON. Well, the head of Consolidated Edison said the other day that after he finished building the plant and got it all set, if we had not solved the insurance problem he would let it stand there idle. So there is no obligation on these people to go ahead if they do not wish to go ahead even though they do invest their money.

I am bringing that up because the announced purpose or aim of the Gore bill is to make sure that we have plants in operation by early dates. The question arises: Is there any other method by which we might make certain that we will have plants in operation by specified dates, say 1960 as a target date?

Mr. DAVIS. Certainly under those that are independently financed, the only relationship we have with them is the licensing procedure.

Chairman ANDERSON. When you said "independently financed," you are not referring to Shippingport?

Mr. DAVIS. I am referring to Commonwealth Edison and Consolidated Edison, as separate projects.

Mr. STRAUSS. Might I interject, Senator, that since this is under private initiative, the Government, it seems to me, would be in no stronger position to demand that they complete a project by a certain time than it would be, let us say, with the Aluminum Company of America if they announced they were going to build a plant and complete it by a certain date. I believe there is no consideration we could assert that would require them on penalty of some payment to the Government to complete a job.

Chairman ANDERSON. I think that is right, and I think that that is why, during the war, the Government constructed the aluminum plants which subsequently private industry took over. If there is a compelling and strong enough reason to build some powerplants, the Government is going to have to build them if they expect to have hem done by a specified time. I am not trying to say, and I am sure you will understand that I am not trying to say that I think there is any compelling reason, necessarily, why a plant should be completed by 1960. If we should, however, decide that it is important to keep up with Russia in this kilowatt race, then the only way that you can be absolutely certain to have plants is by the Government undertaking them or to do as they did in the Shippingport instance where a good deal of the plant was contributed by the Government and the private industry went ahead and completed the generating parts of it, recognizing that the plant would be uneconomic but the Government would learn something by it.

Mr. STRAUSS. Apropos of that, sir, and to correct a part of the testimony this morning with respect to the amount of time required to build the Savannah River plants, I have been provided with a table showing that the President approved the first two reactors on June 8, 1950. The second one of that group went critical on February 20, 1954. It does require a very substantial period of time.

Chairman ANDERSON. Part of the time was spent in getting appropriations through the Congress.

Mr. STRAUSS. I assume the same thing would happen in connection with the Gore bill, because that does not involve appropriations. It is an authorization.

Chairman ANDERSON. Having been told to go ahead with the plant, how long would it take to build it? The instruction to go ahead with the plant would not be made until the Congress passed the authorizing legislation, and appropriations had been made.

Mr. STRAUSS. The President signed the supplementary appropriation on September 27, 1950, so it does not change it very much. It still took a very considerable period of years, and the last of those reactors did not go critical until March 28, of last year.

Chairman ANDERSON. One of the great joys of life, and what makes horseraces, is that there are always two points of view on it. The fact that the site was not selected at the time you mentioned is of some interest, and it was not selected until November 28, 1950, and the permanent construction was not started until March 19, 1951, and the first reactor went on July 4, 1953.

Mr. STRAUSS. The first one went critical on December 28.

The same steps will have to be taken, the sites will have to be selected for these plants, too, and not 1 site, but 6.

Chairman ANDERSON. I do not question that at all, Admiral Strauss. The time elements are right there, and there is no argument about it. It would take some time to get it under way.

I am not saying this is related to the Gore bill, but there has been discussion regarding building these plants, and one of them might be built at Hanford and one of them might be built near Oak Ridge where there was some thought that we were somewhat short of power and so forth, and sites would have to be selected, I grant you that.

I am not trying to say it would not take a lot of work and a lot of time that may be employed in other things.

Mr. DAVIS. These reactor concepts involving five reactors——

Chairman ANDERSON. I want to also add here that in the discussion of the Hanford reactor, I have in mind merely a casual conversation of three mills. When we get down to it, it may be 4 mills and it may be 5 mills and it might be 6 mills.

I have no idea what the figure might be, but any of these figures would still be attractive power in some parts of the country.

Mr. STRAUSS. It will, of course, depend upon what price you are willing to assign or the value you are willing to assign to the plutonium.

Chairman ANDERSON. I wanted to assign current production costs from the other areas, whatever they might be.

Mr. DAVIS. These reactor concepts involving five reactors are in advanced stages of fabrication of reactor experiments. These include the boiling water reactor experiment, the sodium reactor ex-

periment, and three varieties of the aqueous homogeneous reactor—HRE 2, LAPRE 1, and LAPRE 2. Four additional reactor concepts are in, or have firm plans for entering, the reactor experiment phase. Reactors involved include the organic moderated reactor experiment, the second experimental breeder reactor, the liquid metal fueled reactor experiment, and the gas cooled reactor experiment. By 1960 there should be significant operating experience in the reactor experiment phase for at least seven different basic reactor concepts with several possible variations in each.

Many other reactor concepts will continue to receive attention in the developmental phase and exploratory phase of the program, but these will not advance into other phases unless they show significant promise in comparison with other concepts already in advanced phases of development.

These remarks with respect to the status of reactors may be summarized by stating that many promising concepts are in the reactor experiment phase. Operating experience on each of these will be obtained during the next 4 years. While such experience is not absolutely necessary before proceeding with demonstration power reactors, it would be very useful to such demonstration projects and will considerably reduce the technical and economic hazards of such projects. It should enable the demonstration project to bring about more progress in the direction of low cost nuclear power. In some cases results obtained with the reactor experiments may show that a particular concept does not warrant proceeding with a demonstration plant.

These remarks thus far have been directed toward reporting the present status of reactor technology. Advances in other lines are necessary before we can have economically competitive nuclear power. There must be adequate supporting service facilities, including those for fuel fabrication and reprocessing. There are signs of an adequate beginning for a fuel fabrication industry. Quotations can be obtained from several private companies, although unit costs are higher than might be desirable and guarantees of fuel performance are not readily obtainable. The situation with respect to fuel processing is not so favorable. No private facilities are available at the present time and no definite plans for construction of such private facilities are known. Unit costs for processing certain types of fuel in Commission facilities appear to be intolerably high for economic nuclear power. Additional development and pilot plant experience on alternative processes is necessary in this area. Plans for such work are well advanced.

An expanding experimental program has been undertaken to provide a better basis for evaluating potential hazards of operating reactors of various types. Preliminary results on water moderated and cooled reactors are being obtained now. Studies of other systems, including fast breeder reactors, are being included in future planning. It is hoped that information obtained from these experiments will contribute to design of safer reactors.

It may be possible to get a better appreciation of the current status of the civilian reactor program in terms of the overall program objective of achieving economically competitive nuclear power in the United States and abroad by identifying and describing stages of the program along with a guess at the timing of these stages. It should

be recognized and emphasized at the outset that there has been a formal civilian power reactor program for only slightly over 2 years.

We have tried to identify stages which this program will go through as we proceed toward the overall goal of achieving low cost nuclear power. These stages may be described as follows:

Stage I: Present, initial research and development work leading toward economically competitive nuclear power. One full-scale powerplant, the PWR, is soon to be placed in operation to demonstrate full scale technical feasibility. Several reactor concepts are being carried through the reactor experiment stage and other are in the exploratory phase.

Stage II: A few large scale, unecomonic power reactors will be built and used to gain operating experience, to obtain some data on large-scale manufacturing and operating costs, and to demonstrate the lead of the United States in reactor development. Although these reactors will have to be heavily subsidized by the Government or industry in the United States they may be of marginal interest for economic use abroad.

Chairman ANDERSON. May I ask you there how these large scale uneconomic power reactors will demonstrate the lead of the United States in reactor development? They will not be built until after the Russians will have maybe 2 million kilowatts developed and the British will have possibly 1 million developed, and we will have a few hundred thousand. Will you relate that to showing the lead?

Mr. DAVIS. I believe it will probably show the lead in two ways. First of all, I think that the costs of power from these reactors, although uneconomic in this country, may be substantially less than the costs of power from the United Kingdom or Russian reactors.

Chairman ANDERSON. Now Shippingport, we know, will be very high, maybe 50 mills or more.

Mr. DAVIS. Shippingport will undoubtedly be very high.

Chairman ANDERSON. Do you think the British costs will be 50 mills on Calder Hall?

Mr. DAVIS. The British costs on Calder Hall, with no credit for the plutonium, I expect may be half of this actually.

Chairman ANDERSON. With no credit for plutonium?

Mr. DAVIS. With no credit for the byproduct.

Chairman ANDERSON. Do you think it would be fair to give no credit?

Mr. DAVIS. No; I say this is simply what our estimate would be of roughly the cost of plutonium and power.

Chairman ANDERSON. If you credit plutonium in England at the cost that we credit it in the United States to reactors we now have on our production cost of plutonium, do you think the cost in England will be higher than Shippingport?

Mr. DAVIS. No.

Chairman ANDERSON. How would it demonstrate the lead of the United States in reactor development?

Mr. DAVIS. Because the reactors I was discussing here are not the Shippingport reactor, but rather the reactors that will be finished around 1960 and 1961.

Chairman ANDERSON. You mean Commonwealth and Consolidated and Detroit Edison and Yankee?

Mr. DAVIS. Yes, and I believe these will have true power generating costs. While a little higher than the costs of power from conventional fuels in the United States, they will actually be less than they would be from the kind of reactors that the British or the Russians would have.

Chairman ANDERSON. Have you had an estimate on the possible operating cost of either the Consolidated or the Commonwealth or Detroit Electric?

Mr. DAVIS. We have had estimates on some of them, and not on all of them.

Chairman ANDERSON. If we do not have an estimate, how can we guess?

Mr. DAVIS. We have had estimates on some of them, and I am not sure we have them on all of them.

Chairman ANDERSON. Which ones?

Mr. DAVIS. We have had estimates at one time on Commonwealth Edison, and of course on all of the demonstration programs, the Consumers and the Yankee and the Detroit Edison.

Chairman ANDERSON. What do those figures run to?

Mr. DAVIS. I would say generally of the order of 8 to 10 or 11 mills, in that range. I believe it is real cost, and that these will demonstrate to anyone who looks at it objectively that these are in fact well advanced.

I think the other thing that this thing will demonstrate is simply that we have the technology to build these reactors if they are required and that they can be built, and that they will operate. We have an advanced technology which will allow us to build advanced types of reactors. I feel quite sure, myself, that some of these may be of some interest in foreign areas.

Chairman ANDERSON. All right.

Mr. DAVIS. In stage III, advanced reactors will be placed in operation in the United States which may be economic in a few special situations but which in general may be considered to be only the immediate forerunners of economic nuclear powerplants in the United States. These plants will be of designs and costs which can find immediate economic use abroad.

Stage IV: Nuclear powerplants will be put into operation which are economically competitive with the most modern conventional plants in most areas of the United States. Some of these types of reactors will produce comparatively cheap power for use abroad.

Chairman ANDERSON. Can you put a time limit on that stage? When do you think that might come into operation?

Mr. DAVIS. I will comment on that a little later, Mr. Chairman.

The fifth stage, a nuclear powerplant will be placed in operation in the United States which will provide power at substantially lower costs than from competitive fuels. This, of course, is our ultimate goal.

Considering the time required to design and build a powerplant and the fact that there may be an overlap of some of these stages, one can estimate that each stage represents a time of the order of 2 to 5 years.

Chairman ANDERSON. The final stage is some time between 10 and 25 years?

Mr. DAVIS. To get to stage 4, which is really the stage of achieving economically competitive power on a broad basis, rather than in a few

special areas in the United States, may well take us between 10 and 15 years; or that would be my guess. That is strictly a guess.

Mr. STRAUSS. I might add that I am more optimistic, Mr. Chairman.

Mr. DAVIS. This is to have one in operation.

Chairman ANDERSON. We are going to have to keep boxscore and determine whether you are optimistic or pessimistic most of the time.

Mr. STRAUSS. In this testimony, I would like to read an article from the May issue of Nuclear Power, the journal of British nuclear and engineering, which I think you will find of extraordinary interest.

Chairman ANDERSON. When you finish, we will revert to the chairman and have him read it.

Mr. DAVIS. There are clearly many factors which affect the timetable. One set is, of course, the provision of facilities for the other parts of the reactor cycle—fuel element fabrication, chemical processing and waste disposal and so forth. These elements require an aggressive research and development program of their own and, in addition, heavy investments by private industry to provide the services themselves.

In the final analysis, critical and individual judgment will be required to determine which reactor concepts should be maintained and for which objective, which reactor concepts have the necessary potential, and what the development difficulties really amount to. Such decisions cannot ever be avoided or made automatic by any system. We are facing them essentially daily in our current program in our efforts to shorten the time schedule as much as possible within available resources.

Chairman ANDERSON. This is a good statement, as we would expect it to be. It does not tell us too much what the attitude of the Commission is on the Gore bill. I wish you would read the statement that you desire to read now and then would you take your report on the Gore bill, your letter on the Gore bill, and maybe summarize it somewhat briefly and we will put the entire report into the record at this point.

(The report referred to follows:)

ATOMIC ENERGY COMMISSION,
Washington, D. C., May 18, 1956.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: This is in reply to your letter to me dated May 10, 1956, requesting a statement of the Atomic Energy Commission's position with respect to S. 2725 (84th Cong., 1st sess.) and H. R. 10805 (84th Cong., 2d sess.), identical bills authorizing and directing the construction by the Atomic Energy Commission of six nuclear power facilities for the production of electric power.

As we understand the provisions of the 2 bills, they would authorize and direct the Commission to construct 6 nuclear power facilities of different but promising designs, in different geographical sections of the United States where there is a need for additional electric generating capacity, for the purpose of demonstrating the practical value of nuclear utilization facilities for industrial or commercial purposes. The undertakings would be pursuant to section 31 of the Atomic Energy Act of 1954 and, as stated, would be in addition to the reactor development program being carried out by private or public groups under licenses authorized by section 103 of the Atomic Energy Act of 1954.

Prior to commenting with respect to the philosophy of the bills and the effect their enactment would have upon the Commission's power reactor development program, certain more direct comments on the bills seem to us appropriate.

First, the bills provide that the construction program "shall be in addition to the reactor development program being carried out by private or public groups

under licenses authorized by section 103 of the Atomic Energy Act of 1954." It is our belief that this statutory language needs clarification. All power reactor projects now being contemplated by industry on its own or under joint AEC-industry power demonstration reactor program arrangements which will be licensed will, in fact, be licensed under section 104 of the act since none of them appears to have been sufficiently developed to warrant a Commission finding of practical value under section 102 and the issuance of a section 103 license. We assume that the construction projects authorized by the bill are intended to be in addition to these presently contemplated licensed projects. Consequently, it is our belief that the reference to section 103 in section 1 (d) of the bills should be to section 104.

Second, we cannot tell, from the language of the bills whether the six nuclear power facilities which the bills would direct the Commission to construct include presently contemplated facilities which will be constructed pursuant to section 31 of the act. As you know, the reactor portion of the plant at Shippingport will be owned by the Commission. Similarly, a portion of the consumers facility under the first round of the power demonstration reactor program and the reactor portion of the Wolverine and Elk River facilities under the second round of the power demonstration reactor program will all be owned by the Commission. All of these projects represent different promising designs which could, if the intent was to include them, fulfill two-thirds of the bill's requirements.

Finally, we point out that no substantive legislation is necessary to authorize the Commission to construct full-scale demonstration reactors. Section 31a (4) of the Atomic Energy Act of 1954 authorizes the Commission to engage in research and development activities relating to "the generation of usable energy, and the demonstration of the practical value of utilization and production facilities for industrial or commercial purposes." The report of the managers for the House, accompanying the conference report on the Atomic Energy Act of 1954, states that this language was intended "to clarify the authority of the Commission to build or to contract for the building of large-scale atomic energy utilization facilities for the purpose of demonstrating the practical value of such facilities in the generation of electricity." Colloquies occurring in the Senate on the conference report disclose a similar understanding. Accordingly, the bills would not add to the Commission's substantive authority. They would rather direct the Commission to exercise its existing authority under section 31 by constructing six plants of the character and location indicated, and would authorize necessary appropriations for that purpose.

As a general proposition, the Commission recognizes that construction of full-scale prototype nuclear powerplants is a necessary and vitally important step in the development of economically competitive nuclear power. It also recognizes that the construction and operation of such prototypes must be subsidized by Government or industry or both inasmuch as such plants are not likely, at this stage of the art, to be economical. The Commission takes the view that while it must take the lead and carry most of the burden of developing nuclear power reactor technology, industry should take the initiative and assume the major responsibility for full-scale prototype reactors. Some Government financial and technical support may, of course, be needed, but the direction and level of this support should remain flexible to meet the needs of particular situations and stages of development.

The proposed legislation therefore raises fundamental questions with respect to this existing Commission policy since it would direct the AEC to undertake with public funds a major portion of the prototype reactor phase. Which of the alternatives is the best must be resolved in terms of which will result in the greatest long-term good to the Nation. This, of course, will depend on what is the long-term goal. It has been, and is, the Commission's view that the goal of United States policy should be the eventual development of economic nuclear electric power and not an immediate kilowatt race with other nations. It should be clearly emphasized that it is our belief that an aggressive and continuing reactor research and development program is the only basis on which we can establish and maintain world leadership in the development of nuclear power and achieve our goal of economically competitive nuclear power in the United States. To prevail in a nuclear kilowatt race might, in the short run, appear to be an accomplishment, but we fear that it would not only be unduly costly in terms of the benefits to be gained, but that it would divert effort and scarce technical manpower from the real goal and consequently delay its achievement. The attainment of competitive nuclear power in the United States, with its efficient con-

ventional powerplants and relatively cheap fuels, is going to be difficult. We cannot favor a measure which sets an arbitrary goal in terms of the number of nuclear power facilities without providing the flexibility to take into consideration the competing, and in our view paramount, demands of research and development.

While the AEC has often made economic analyses of nuclear power, it recognizes that these estimates have not generally been made with the detailed industrial utility background on the overall economic considerations involved in financing, engineering, construction, operation, and distribution of added capacity on a systems basis. It is our belief that publicly, cooperatively, and privately owned utilities engaged in the sale of atomic energy and equipment manufacturers are in a much better position than the Commission or its laboratories to assess the economics of particular reactor concepts and to determine which ones are in the stage of development where the construction of a prototype is a logical and appropriate step. For these reasons the Commission has encouraged industry to undertake the construction and operation of full-scale prototypes. However, if a particular reactor concept appears to us to have reached the stage of development where the construction of a prototype is a logical and appropriate step, and if it should appear, after appropriate public invitations for proposals for joint AEC-industry projects, that industry is not prepared to undertake the construction and operation of such a prototype, the Commission would give serious consideration to the desirability of going forward with the project using entirely public funds.

The prototype stage in reactor development is largely concerned with establishing and reducing construction and operating costs and it is therefore the final stage in the approach to economic nuclear power. We believe it to be of the greatest importance that the maximum economic incentives to cost reduction be preserved at this stage. This, in our opinion, can best be accomplished by industry taking financial and technical responsibility under conditions where it will sustain the major burden of whatever loss occurs and accrue the advantage of any economies. Government assistance in some respects may be necessary, but we do not believe that Government responsibility or Government cost contracts are likely to sufficiently provide the desirable incentives to cost reduction.

In our opinion, American industry is responding to this challenge in a very encouraging manner. It cannot be overlooked that we have had a formal power reactor development program for only slightly more than 2 years and that this length of time is wholly insufficient for the development of the vast technology necessary for construction and operation of really economic power reactors of any size or type. In addition, there are many problems such as insurance, chemical processing, and reactor hazards which contribute to the difficulty of initiating a nuclear power industry. However, solutions to these problems are being worked out and the development of the necessary scientific and engineering technology is proceeding.

Negotiations are going forward on the 3 proposals made and accepted under the first round of the power demonstration reactor program and on the 2 accepted so far under the second round invitation. The other five proposals under the second round are still being considered by the Commission. Four private reactor projects of very large size have been announced and are in variously early stages of prosecution. One power reactor and several research reactors have been sold abroad. Several additional foreign power reactors are know to be under very active consideration.

Summarizing the Commission's policy in juxtaposition to what appears to be the philosophy of the bills, it is the Commission's view that the primary goal of its power reactor program should continue to be on research and development as opposed to kilowatts of power, that the construction of prototypes should be based upon the state of both nuclear and conventional power technology and costs in the United States as opposed to the quantity of nuclear electric power being produced in other nations, that the erection of facilities, primarily for the purpose of producing electricity, should be left, with certain concessions which may be appropriate, to the laws of economics, and finally, that the Commission should, rather than be bound by a statutory direction, be permitted the operational flexibility to construct facilities when, in its technical judgment, such facilities and the technical manpower their construction will involve will be most productive of a meaningful technological advance.

Wholly apart from this difference in philosophical approach, enactment of the bills would create some extremely serious problems, several of which we should

like to point out. First, enactment of the proposed bills would lead to implementation problems of considerable magnitude. If these projects are to be a part of a strictly Government program, the solution of these problems would fall upon a staff that is now fully engaged with existing phases of the nuclear power development program. Some appreciation of the magnitude of the task may be gained by a comparison with the construction of the Savannah River plant of the Commission. Savannah River involved 5 reactors of identical design by a single major contractor on 1 site with related feed materials, processing, and other service facilities. Subject to doubts we have already expressed, we interpret the provisions of S. 2725 and H. R. 10805 to require construction of 6 reactors, not already in contemplation, of 6 different designs in 6 different geographical sections of the United States. Several different major contractors undoubtedly would be involved. The mere selection of contractors for research and development, design, construction, and operation of these plants would be a major undertaking in itself. It is unlikely that this can be done without interfering with other major reactor efforts, military or civilian, or without providing some new facilities to equip new contractors in the reactor business. In addition, service facilities such as fuel preparation and processing would be necessary although they could perhaps be lesser in magnitude than at the Savannah River plant.

Second, there are the two inseparable problems of site selection and disposition of power. Site selection, given the criteria provided in the bill, is not, in and of itself, too difficult a problem to resolve. However, when its effect upon the disposition of the power generated is taken into consideration, it has a great many far-reaching consequences. It must first be recognized that the product of a nuclear power facility will be unfirm for at least a 5-year period due to the experimental nature of the facility. This means that the capacity of any system into which the power is introduced must be sufficiently large to absorb the reactor facility's output on a continuous basis and have the reserve capacity to provide standby power during time of reactor shutdowns. These factors themselves place limitations on the potential sites, although it may be assumed that there are some privately owned, some publicly owned, and some AEC-owned sites which could qualify. If sites were selected which would enable use of the power by the AEC or other Government agencies, no substantial additional problems of disposition of power would develop. However, since the power generated would, for an initial period at least, be unfirm in nature, it would have a limited usefulness to the AEC and, considering its high-cost nature, the total cost to the AEC resulting from its use plus the charges which would have to be paid for standby power would greatly exceed present power costs.

The alternative to use of the energy by the Government itself would be a sale to some distributing system for ultimate use by nongovernmental consumers. The fact that the bill would direct the Commission, in selecting sites, to consider "the need for additional electric generating capacity in the region of the site under consideration" suggests that the Commission is to consider the possible needs of ultimate nongovernmental consumers for the energy generated from the reactors which it would be driected by the bill to construct. Any such disposition of nuclear energy would involve the Commission in complex problems of interpretation and administration of the preference provisions of section 44 of the act on a scale for which it is not presently staffed or equipped. The distribution problems would be rendered particularly acute by reason of the fact, already pointed out, that for some years at least the energy will be of relatively unfirm character. And, since the location and perhaps the size of the facility might have a substantial effect upon the ability of preference or nonpreference groups to utilize the power, it is reasonable to predict that, even on these essentially technical matters, the AEC would find itself caught in the crossfire of the public versus private power controversy.

The desire to avoid a diversion of effort from its primary function of furthering research and development in nuclear technology through becoming involved in administrative and political problems such as have been mentioned above is an added reason why the Commission would be most reluctant to be required to embark on a major program of constructing, and presumably operating, full-scale nuclear powerplants.

It is our conclusion that we are opposed to the enactment of the proposed bills. They place upon the Commission an arbitrary and inflexible requirement which would divert vital research and development effort to less productive work. It would also lead to reactor prototypes being constructed without the all-important economic incentives. The absence of these incentives would, in our opinion, delay

the day when nuclear power is likely to become economically competitive in the United States.

Without specific knowledge of the types of reactors to be built, their size, location, and other relevant factors, it is not possible to estimate with any accuracy the cost of the proposed program. However, on the assumption that the bill would call for large output reactors, we believe that cash expenditures would probably be in the order of $400 million for the development, design, and construction of the reactors and generating facilities, and that they would require 4 to 5 years for completion. Operation of these plants, for 5 years after construction had been completed, would probably require an additional $200 million or so, making expenditures for the program about $600 million for a 10-year period. This, of course, does not include the cost of construction and operation of auxiliary facilities for transmission, fuel reprocessing, etc. The value of the power produced during this period would probably offset no more than one-quarter of the total expenditures.

All of the views expressed in this letter are not concurred in by Commissioner Murray.

The Bureau of the Budget has advised us that it has no objection to our transmitting these comments and that it concurs in the conclusions expressed.

Sincerely yours,

W. F. LIBBY, *Acting Chairman.*

Mr. STRAUSS. I do not know whether this will be as interesting to you and to your committee as it is to me. It has just been handed to me. I wish there were a similar journal published in Russia.

This is a British publication, Nuclear Power, the Journal of British Nuclear Engineering, and it is the May issue.

Out of the Geneva Conference emerged a great many facts, most of them scientific. One, however, was not and in its way it was of far greater importance to far more people: the United States now regards atomic energy as very big business. Paradoxically, the Americans have less incentive to develop nuclear power for their own use than any other country in the world, for nowhere is conventional power so cheap and so plentiful, and their vigorous policy of encouraging the development of a great variety of reactors is clearly designed to produce as quickly as possible one which will be suitable for export. Her friends will put this down to an enlightened desire to raise the standard of living throughout the world in accordance with the spirit of the United Nations Charter; her enemies will see it cynically as just anothser move in the cold war. On reflection, however, it will be seen that these diagnoses really amount to the same thing.

The character of the American exhibits at Geneva, and even more so the announcement by Lewis Strauss that America is now prepared to sell or lease research amounts of uranium 235 and heavy water at prices which made delegates gasp, left one in no doubt as to what the next move would be. Now it has been made and President Eisenhower offers no less than 40,000 kilogram of uranium 235 at $25 a gram. Of this, half is for export, but not to Soviet-bloc countries and not to Britain and Canada, because we make our own.

There are always two ways at least of looking at an action, and if to British eyes the Eisenhower bargain looks like an old-fashioned piece of economic imperialism, in countries lined up to receive supplies of enriched fissionable material it must seem a most generous gesture of international cooperation. Probably the latter is much nearer the truth, for the price quoted is almost certainly marginal and can have little relation to the gross cost when capital charges on the plant are included—to say nothing of normal commercial profit. Nevertheless, the news must sound very good to American industry, for thereby it is automatically placed in an extremely strong position to offer in the not-too-distant future complete nuclear powerplants backed by positive assurances that the appropriate fuel will arrive at the same time as the reactors. Beneficiary countries, too, will welcome the news because they will now be able to go ahead and plan programs based on realistic assessments of costs, secure in the knowledge that there will be no power cuts through fuel shortage. This cannot make pleasant thinking in British industry.

The initial stages of our nuclear energy program is, owing to force of economic circumstance, completely one-sided. In the construction of power stations for our own use we are well ahead of America, and although it is now apparent that the white paper program is inadequate in scale as it stands, there is little argument that it is basically correct in principle.

Chairman ANDERSON. Would you read that again?

Mr. STRAUSS (reading):

In the construction of power stations for our own use we are well ahead of America, and although it is now apparent that the white paper program is inadequate in scale as it stands, there is little argument that it is basically correct in principle. Yet it is extremely doubtful if the graphite-moderated gas-cooled reactor ever really was an exportable proposition. Unfortunately it is the only one we have within sight of being operational. True, it does use natural uranium, the obtaining of which is not comparable in difficulty with the production of enriched material, but the capital cost, on account of its size, is very great and any attraction it may once have had for other countries considering a nuclear power program at this stage must have largely evaporated with the news that enriched fuel can now be obtained from President Eisenhower.

Platitudinously, we must export or starve, and what better to export than nuclear powerplant? There is no lack of enthusiasm among British engineering firms to throw themselves wholeheartedly in to this task, but it is obvious that they are inhibited until such time as the Government is prepared to give assurances that fuels of the correct kind will be made available at definite prices.

Time is very much not on our side in this matter. True enough, the American uranium will not be required except in research quantities until there is a fully tested power reactor available.

They do not have one.

Even in America this does not exist yet, but it is clear that of the several potentially useful designs of enriched-fuel thermal reactors now under development in the United States, at least one, and probably more, will have asserted itself as a normal piece of industrial equipment by about 1960 at the latest. In Britain there is at present no sign that a comparable situation will obtain at that time. It is possible, of course, that there will be no strings attached to the President's offer and that American fuel might be used in a suitable British reactor should one be produced, but to a country starting this business for the first time, the arguments for buying all-American must seem very cogent.

In the matter of design of enriched-fuel thermal reactors it should not be assumed from a study of the Geneva papers that all difficulties have been overcome and that they are now due off the production line. There is no evidence, for instance, that all the metallurgical problems have been solved or that entirely satisfactory control systems have been devised, but it would at least be prudent, knowing American industry, to assume that these troubles will, in the end, have amounted to no more than rather irritating delays. In Britain there is no comparable development, for although private industry has been fully used in constructing research and power reactors—and has undoubtedly gained invaluable experience in this way—it has not yet had an opportunity of assuming complete design responsibility for a major project.

Unfortunately, design cannot precede research, and when it comes to the enriched-fuel heterogeneous reactor there is still virtually no British experience, although LEO, now under construction for the UKAEA, will provide some. Under the terms of the Anglo-American agreement of last year, Britain was precluded from classified information on reactors which we were not actually building or had projected. This had the curious effect of a full exchange on fast breeders and homogeneous reactors, but not on the ones of most immediate interest. Presumably, now we are building LEO, we will be eligible for some of this information, but not before the American firms have opened up a big lead.

We are therefore faced with a highly adverse situation. Nevertheless, if resolute Government action is taken soon the position can be retrieved. What is needed first and foremost is the agreement on fuel. It is clear that our output of enriched uranium from the Capenhurst diffusion plant and of plutonium from the Windscale plant cannot begin to match the American output, and indeed Sir Anthony Eden has said that he can hold out no hope of being able to follow President Eisenhower's lead. The situation is, of course, highly dependent on military requirements and while these must remain purely speculative owing to the almost total lack of data, one is led to the question, How big has the weapon stockpile got to be before the claims of private industry to a share in this national product can be considered? The time has surely come when this matter must be reviewed at the highest possible level.

This fuel is not needed tomorrow, but unless really practical amounts, at prices at least comparable with the American figures, can be guaranteed it is not going to be easy to persuade firms to invest large capital sums in the design of nuclear powerplant. In the House of Commons recently Mr. Butler said that long-term plans were already under discussion for the export of power reactors, but that the demand was unlikely to be substantial for some years. Is this the true voice of the nation of shopkeepers? Surely not. If we had a practical, economic nuclear power reactor ready for export now and backed by an assured fuel supply, is there any doubt at all that we could sell it?

Perhaps it is true that British industry would probably merely be embarrassed by a request from abroad at the present time for a nuclear powerplant, but there is no reason to doubt that it is willing and able to push on with development work now if only the Government were prepared to give it a lead and free it from the state monopoly in the same way that American industry has been liberated. There is even less doubt that their product would be second to none.

President Eisenhower's offer, then, must be seen in a global light and although the full technical, legal, and commercial details have yet to be settled, it must be recognized that throughout much of the world it is being hailed as proof that "Atoms for peace" means more than just an occasional scientific "beano" with gentlemanly exchanges of unclassified information, and is a serious and well-intentioned effort to bring actual atomic power to countries that really need it. Britain can and must do the same. Back in 1945 we found ourselves odd man out: let us make sure that 1956 does not find us the man who never was.

Mr. STRAUSS. I get a certain dry pleasure from reading that article.

Chairman ANDERSON. Would you now take the letter which transmitted the Commission's point of view on the Gore bill?

Mr. STRAUSS. The points in this letter were largely covered in the course of my testimony this morning. Do you wish it read into the record?

Chairman ANDERSON. No, I thought that you might briefly summarize what the position is.

Mr. STRAUSS. Might I ask the General Counsel, this being a formal document, if he would?

Chairman ANDERSON. Perhaps I can summarize it briefly. Are you for or against it?

Mr. STRAUSS. We are against it.

Chairman ANDERSON. I think that summarizes it.

Senator GORE. May I ask a question. Is your mind open or closed?

Mr. STRAUSS. I hope it always remains open, Senator Gore, on the estimable example that you set this morning.

Chairman ANDERSON. I thought probably, Mr. Chairman, you might want to touch some of these items in this. If you would like to have Mr. Mitchell do it, we can have him do it.

Mr. STRAUSS. I think Mr. Mitchell can do it more briefly and more intelligently than I can.

Mr. MITCHELL. I doubt the latter, Mr. Chairman, but I will be glad to try.

First of all, we summarized the provisions of the bill as we understand them and then we go on and make certain specific comments and general observations. The first point is that we think probably the reference to section 103 of the Atomic Energy Act would be more properly section 104. That is "Research and development licenses" under section 104.

Our next point is that there is some doubt in our minds as to whether the bill contemplates that certain facilities which we already have under way would be included in the six.

For instance, at Shippingport we will own the reactor portion of the plant. Similarly a portion of the Consumers facility, Consumers

Public Power of Nebraska, will be owned by the Government. This is true, also, of Wolverine and Elk River. If you included these 4, then presumably the bill would require only 2 additional plants and the alternative would be 6 additional, and we are not quite sure which is intended.

Chairman ANDERSON. If you are going to own the nuclear core of Consumers Public Power, and you are going to own the nuclear core of Duquesne Public Power, why could the Commission not continue to own these cores and farm these out to private individuals for six test plants around the country expeditiously? Why could not the same technique in other words, that you plan to use in Shippingport where their financing problem is solved by the Atomic Energy Commission putting up nearly all of the money, be solved by trying out some of these other types of reactors with the Commission again putting up all of the money?

Mr. MITCHELL. So far as legal authority is concerned, I can speak to this and certainly the Commission could do it. As to the technical problems, the time element would be important and others here could better answer that. This next paragraph is that same point.

Chairman ANDERSON. Which paragraph are you referring to?

Mr. MITCHELL. The middle of page 2, Mr. Chairman. The Commission presently has authority under the existing statute to go into a program of this kind.

Chairman ANDERSON. I do not believe the point of the Gore bill was that you did not have authority. The point was that you were not going to do it and it took a directive to get it done.

Senator GORE. Mr. Chairman, may I make a brief comment about these three points. The first point that the chief counsel raised is that there is some possible doubt as to whether it should apply to 103 or 104. So far as I am concerned, it can apply to both.

The second point is whether it is supplementary to, and it is my intention that it be entirely supplementary. No. 3, as to the authority, the 1954 act does not authorize appropriations for this purpose. In the statement of the Chairman this morning, he said that if and when the Commission became convinced that this kind of program was needed, the Commission would request authorization and appropriation. No appropriation could be made for this purpose, for the purpose of the Government construction of a reactor for industrial power or commercial power, without further authorization.

Chairman ANDERSON. That was the whole point of the Johnson amendment which had to be dropped in conference or we would have had no atomic energy bill in 1954. That was the price that was extracted in order to pass a bill at all.

Senator GORE. In other words, that is one way, Mr. Mitchell, in which we lost the 1954 fight. You are authorized to do it, but the Congress is not authorized to make any appropriation for it without further legislation.

Mr. MITCHELL. You are perfectly right that this would be an authorization for appropriations, which otherwise we would have to receive separately.

Senator GORE. I am glad to see that we are going together, Mr. Chairman.

Chairman ANDERSON. We have open minds.

Mr. MITCHELL. The balance of the letter, Mr. Chairman, is a summary, I think, of the statements which have already been presented to this committee. I do not know whether I can usefully try to repeat them.

Chairman ANDERSON. Could I take the paragraph right after the one you were referring to a moment ago, that is, the last paragraph on page 2 where you say:

> As a general proposition, the Commission recognizes that construction of full-scale prototype nuclear powerplants is a necessary and vitally important step in the development of economically competitive nuclear power. It also recognizes that the construction and operation of such prototypes must be subsidized by Government or industry or both inasmuch as such plants are not likely, at this stage of the art, to be economical. The Commission takes the view that while it must take the lead and carry most of the burden of developing nuclear power reactor technology, industry should take the initiative and assume the major responsibility for full-scale prototype reactors.

Who provides the direction in which they shall go, and who gives them the spur to keep them moving on it?

Mr. MITCHELL. Well, sir, I think that on this point, both the Chairman and Mr. Davis indicated in their statements as to our reasons why we thought that industry should be given this responsibility.

I think this point that you raised in connection with industry doing full-scale prototypes refers to testimony we put in earlier by Mr. Strauss and Mr. Davis. I believe the balance of the letter, Mr. Chairman, is a summary paralleling what we have already said.

Chairman ANDERSON. I think that it follows the testimony of the Chairman and Mr. Davis.

Senator Gore, do you have any questions?

Senator GORE. I have no questions.

Mr. MITCHELL. There is one further point, Mr. Chairman.

On page 7 we do include an estimate of the cost. I do not know that we referred to this before. That is all I have unless you have some questions.

Mr. STRAUSS. This has a bearing, Senator, on your guess which was not far out of line this morning as to what a program would cost. You said in the neighborhood of $500 million. This says $400 million, and this makes the point that the first cost is not the whole story, since these would have to be operated at a loss, an annual loss over the period of their lives.

Chairman ANDERSON. There would not be a net loss, though, to the Government, would there, if the private companies go ahead? They will have to operate at a loss That loss will merely come out of their profits, and the Government would recover a portion of the profits if they had made them.

Senator GORE. Or from the subsidy of the Government. All of the reactors under construction now will be operated at a loss to the taxpayers of the United States.

Mr. STRAUSS. That is true, but the presumption is that, as we progress with their technology, the reactors will more and more approach a state of economic operation whereas to build 6 reactors now at the present state of technology would be to produce 6 known uneconomic plants.

Senator GORE. I would like to have Dr. Zinn reply to that, if he might. What are the prospects, Dr. Zinn, of making improvements and developing more economical power from reactors with which we have already had experience?

Dr. ZINN.* By reactors with which we have already had experience I presume you mean large-scale reactors and not small experimental reactors.

Senator GORE. I am afraid I do not have sufficient technical knowledge to try to confine your answer. You proceed and give the answer as you see fit.

Chairman ANDERSON. Suppose we take the example of the Hanford and Savannah reactors, and you are familiar with those.

Senator GORE. And also the 1942 reactor which we have not further developed, and upon which Britain is now principally relying, or any others.

Dr. ZINN. You have to realize that up to now the program in this country for power development has been one oriented towards economic power. Therefore, there has been an attempt to choose reactor types which seem to have a preferred position in getting to economic power. It turns out that when you do this, one usually prefers the reactor which will give the greatest amount of power in a mechanical and electrical system of the smallest capital investment and also the smallest fuel investment.

In other words, the rating of the reactors is made high.

In contradistinction to this, the British have adopted a type of reactor, the gas-cooled reactor, where the rating is low. It is this point that was referred to in the Chairman's reading of this editorial in the magzine. The reason for choosing the low rating in the British case was given as safety. There is every reason to believe that the lower the rating, the safer the reactor is. So you cannot use only the goal of economic power which is gotten by high rating as a measure of which reactor you ought to choose to develop.

It seems to me that if your proposal to expand the construction of reactors were to be undertaken, and you wanted to be sure to include

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*From the Office of the Joint Committee on Atomic Energy.
(For release in morning papers, Saturday, May 5, 1956.)
Dr. Walter H. Zinn, Director of Argonne National Laboratory, has agreed to serve as a part-time technical consultant to the Joint Congressional Committee on Atomic Energy while the civilian reactor program is under study. The appointment, which will run until July 1, 1956, was announced today by Senator Clinton P. Anderson, chairman of the Joint Committee.

Dr. Zinn has been engaged in research and development work in the field of atomic energy for more than 17 years and has served as Argonne's Director since July 1, 1946, when it was established as the successor to the wartime metallurgical laboratory of the University of Chicago. Among the many contributions to the Nation's atomic-energy program by Dr. Zinn and his staff, the following are particularly noteworthy: the design and construction of the world's first heavy-water moderated reactor; the development of the basic design of the first nuclear reactor for propulsion (U. S. S. *Nautilus*); the development of the basic design of the production facilities for the Commission's Savannah River plant; the first production of electricity from nuclear energy; the first breeding of nuclear fuel; and the generation of electrical power by a boiling reactor system and its subsequent use by the community of Arco, Idaho. Many of the reactors being designed and constructed by the electric utility industry are based on pioneer development work performed by Dr. Zinn and his staff.

In making the announcement of Dr. Zinn's selection, Senator Anderson stated:

"Dr. Zinn's many notable contributions to the advancement of the atomic-energy program in this country and throughout the world are well known. Because of his great knowledge in the fields of reactor development and nuclear physics and because of his awareness of the problems associated with this important work, he will be able to make many contributions to the committee's appraisal of the reactor development program. The committee is greatly pleased and honored to be able to avail itself of his services."

all types of reactors which have some chance of being economic some time, you ought to include gas-cooled reactors, and you ought to include the graphite moderated, and water-cooled reactors of the type developed at Hanford, and you ought to include the heavy water-reactors which hold out the greatest promise for giving power and perhaps economic power without resorting to the use of enriched uranium.

I say this, repeating again that if you are holding out for an expanded program. Up to now it should be clear that we have had to choose what seemed to be the best bets for economic power. That is not only now, but for the long range.

Chairman ANDERSON. And you think pretty largely those best bets have been chosen.

Dr. ZINN. Some of those of us who are engaged in the pioneering research and development have been hunting around for better bets all of the time and some of the ones that we have found may not be better bets. But you have to try them out.

Representative COLE. Have you been disappointed in the choice of the Commission?

Dr. ZINN. Well, I would say that I have not been disappointed but I do not agree that it is the choice of the Commission, either. Choices have been made, and I think it is wrong to say that the choices are the choices of the Commission. The power-demonstration program, it seems to me, involves a proposal, and the choice is made by somebody else and the proposal is made to the Commission. I do not think that the Commission has undertaken to tell the people what kind of proposal they should choose.

Representative COLE. Subject to revision, are you satisfied with the selections of the various types which have been made by somebody, either by the Commission or the private operators?

Dr. ZINN. I think if you limit the amount of construction that is to be undertaken to the kind of program we now have, our choices are as good a bet as anybody. This can be seen by noting that we are being sincerely flattered by being imitiated. Both the British and the Russions apparently are trying hard to come through with programs which imitate ours.

Senator GORE. Is this true of all of the Russian reactors?

Dr. ZINN. There is only one Russian reactor which is different from ours, and it is a gas-cooled heavy water moderated reactor. If we include the fact that we do have the Hanford type of reactor but not as a power reactor, the Russian program, their main program is really a graphite moderated pressurized water reactor which is a model of the Hanford type.

Chairman ANDERSON. Could I just add here this word that Dr. Zinn is a temporary consultant to this committee, available to all members of the committee. He had a short period of time before he undertakes some new work and it seemed to me that his long experience in reactors would be worthwhile to members of this committee. I, therefore, have asked him to sit in here and to be available to any member of the committee who cares to consult him on this question of reactors. Therefore I am glad that Senator Gore has asked him for a brief statement at this time.

Senator GORE. I may have improperly done so, because later on I am sure the committee will want to hear Dr. Zinn, and I intended no

impoliteness to the Chairman of the Commission in interrupting his statement.

Chairman ANDERSON. It was not improper at all. We are all glad to have him here, and we appreciate the fact that he is here, and he is going to get nearly enough money to pay a portion of his hotel bill each day. We appreciate his courtesy in being here and I am sure all of us do.

Mr. STRAUSS. I would simply like to say on behalf of the Commission that the committee could not have selected a better qualified or more competent counselor on this subject.

Chairman ANDERSON. We are very anxious, Mr. Chairman, to make sure that whatever steps we take will help and not hurt the program in the United States.

Representative HINSHAW. As one who has been interested in the research and development subcommittee work for a great many years, may I ask what has happened to the program that the subcommittee recommended some years ago, that the earlier attempts at commercial production of electric power be built in those portions of the world which could at that time profitably use the power at the cost at which it would be generated? It was presumed that certain countries of the world with high-cost power, that a reactor built in such a part of the world in accordance with the article that my friends from Britain wrote and which Mr. Strauss read a few moments ago, would be such that we could well afford to export that reactor to such a country. Thereby we could gain a start at something that would be less than a loss.

I attempted to make some figures a while back in the course of hearings, and these have been made and they may have decimal points wrong, Mr. Chairman, but those who run slip sticks and slide decimal points around, I would be glad to have them check these.

Chairman ANDERSON. Mr. Hinshaw came up with some very interesting information one day, I might explain, very challenging to all of us, and then he was honest enough afterward to admit that he had just misplaced the decimal point.

Representative HINSHAW. Working very rapidly with these figures, I come up with the astounding thought that 1 mill per kilowatt-hour loss on the useful production of 100,000 kilowatts per day, for 100,000 useful kilowatts produced from a plant which I presume would be something like 125,000-kilowatt plant—am I correct so far? That would be on the order of 24 times $100, or $2,400 a day.

Mr. STRAUSS. It sounds right.

Representative HINSHAW. Multiplied into a year, upon which we are accustomed to figure, it should equal $876,000 a year loss, per mill of loss per kilowatt. Is that correct?

Mr. STRAUSS. It sounds all right so far.

Representative HINSHAW. Dr. Libby checked me before and now Dr. Libby can check me again.

Dr. LIBBY. That is right, sir.

Representative HINSHAW. If we lost 1 mill per kilowatt-hour, that is if it costs 1 mill per kilowatt-hour above an economical rate such as a cent or half a cent or whatever it is they can produce power for, that is a loss of $876,000 per year on such a type of machine.

It is not inconsiderable but to a country that can use 10-mill-per-kilowatt power and make a profit at it, it would be well worthwhile for

them to have one of the present high-cost reactors. For us to build it experimentally in that country would not be a dead loss.

In this country in a few years, it would have to be torn down and thrown away because obviously it would be run at a loss.

Chairman ANDERSON. I think it is a very good suggestion. I realize that there may be objections raised to that, but certainly there are areas in the world that can use power at high cost.

Representative HINSHAW. I can think of no better thing for the United States to do with its foreign-aid program than to place several of these reactors in high power cost countries, thereby perhaps earning its cost ultimately.

Mr. STRAUSS. As the committee knows, the negotiation of bilateral agreements looking toward the construction of power reactors in friendly countries is a matter of fairly recent occurrence. I do not know whether Mr. Hinshaw is aware of the fact or not that a reactor has been sold to Belgium to produce 11,500 kilowatts, an American reactor, which is to be completed by April 1, 1958.

Senator BRICKER. Is that to an industrial concern?

Mr. STRAUSS. An industrial concern, yes, sir; but the agreement is with the Government.

Representative HINSHAW. That is in the nature of a world exhibit.

Mr. STRAUSS. It is to be used initially at the World Fair and then the company which has bought it, which is the company that supplies the city of Brussels with power, is simply going to turn it into their grid.

Representative HINSHAW. No one will even begin to think that that 10,000-kilowatt reactor can be economical.

Mr. STRAUSS. No such representation has been made by the sellers, or was asked by the purchasers.

Representative HINSHAW. It is an opportunity more than anything else.

Mr. STRAUSS. It is a whole lot nearer the cost of power in Belgium than, of course, it would be in this country. I do not know what the precise cost will be.

Chairman ANDERSON. It is still not very close to the cost of power in Belgium.

Representative HINSHAW. I would just like to express those thoughts.

Senator BRICKER. What is the estimate of cost of the kilowatt production of this 11,000-kilowatt plant?

Mr. STRAUSS. Can Mr. Davis give us an estimate of the cost per kilowatt-hour of energy produced in the Belgium reactor?

Mr. DAVIS. I was just checking and I do not believe we have any, but I would guess it would be of the order of 15 to 18 mills, in this range.

Senator BRICKER. Belgium has to import all of its coal.

Chairman ANDERSON. As Mr. Hinshaw points out, Dr. Davis, if we got down to a 10-mill cost, which is as you have pointed out almost within the range of vision, a 10-mill cost would be very attractive in certain Latin American countries, would it not?

Mr. DAVIS. Yes. I believe the only difficulty there would be whether they could take as large a block of power as would be necessary in order to get the cost down to 10 mills, you see.

Chairman ANDERSON. It is like Anchorage, Alaska. They could not use much power up there because the cost is 3 or 4 cents a kilowatt, and finally the Government started to build a plant there which was going to bring the cost down to a few mills, and then they built some other plants, and now they cannot keep up with the demand at Anchorage because the minute you drop the cost of power down to 10 mills in place of 30 mills, you find that people decide they will put in electric stoves after all and they will use an icebox after all, and——

Mr. STRAUSS. In Alaska?

Chairman ANDERSON. Yes, they do, strangely enough. They have some warm weather in Alaska.

Mr. DAVIS. I think the cost is around 8 or 9 mills for present power.

I might make one other observation on Mr. Hinshaw's comment, and that is by having a 10,000-kilowatt reactor instead of 100,000-kilowatt reactor, at least they are having the reactor and getting experience and it only costs them $80,000 a year instead of $800,000 a year. So to this extent they are ahead.

Representative HINSHAW. I was referring to a loss on the basis of competition with any reactor that can be figured today, and built today with the current cost of generation of electric power in the United States, which is never more than 5 mills, I believe.

Chairman ANDERSON. It is 9 mills.

Representative HINSHAW. In the United States? We produced power in all of these hydroelectric projects for a quarter of a cent, 2½ mills.

Chairman ANDERSON. You can look at the record of the high cost areas in the United States in certain parts of the New England States, and in the pockets around Minneapolis, and in the 1 section of the Rocky Mountain area, and you will find lots of 9-mill current.

Senator GORE. Some of the power in the Upper Colorado program is going to cost 8 mills. Excuse me, that is a soft spot.

Representative COLE. If I may and if you have finished that discussion, my eye was struck by an expression in the letter of the Commission to Senator Anderson. At the bottom of page 3 it says:

> However, if a particular reactor concept appears to us to have reached the stage of development where the construction of a prototype is a logical and appropriate step, and if it should appear, after appropriate public invitations for proposals for joint AEC-industry projects, that industry is not prepared to undertake the construction and operation of such a prototype, the Commission would give serious consideration to the desirability of going forward with the project using entirely public funds.

That prompts the question of Chairman Strauss. It is a fair conclusion to draw from that statement that there are no reactor concepts which have progressed through the stage of development to the point where it appears wise that a full prototype model be constructed?

Mr. STRAUSS. It is my understanding, Mr. Cole, as of this moment, that that is a fact. I went further in my statement this morning, to say that if that situation ever developed, I would recommend it to the Commission. I believe that the Commission would act promptly under those circumstances.

Representative COLE. Now, does Dr. Zinn have any disagreement with the conclusion Mr. Strauss has indicated?

Dr. ZINN. Well, I could not agree entirely with what he has said because it gives the impression that somewhere somebody is always

trying to say "Well, do we have a proposition now that we can make to the Commission?"

I do not believe that that is the way the thing operates. I think that the Commission advertises that it will listen to propositions of a certain magnitude and then people decide to make an offer.

Representative COLE. On the question of magnitude, I do not understand just what you mean by "magnitude" because some of the Commission projects are 10,000 or 20,000 or 100,000. What order of magnitude do you mean?

Dr. ZINN. The first demonstration program called for reactors in the range of 75,00 or something like that.

Mr. DAVIS. There was no limitation.

Dr. ZINN. They all came in fairly large. We know that large ones have a chance of making economic power, or a better chance.

The second round was advertised for small reactors, as I recall. And I think the feeling is not that just as soon as you have something that you think could be built that you go to the Commission and make them a proposition. I do not think it works that way.

Representative COLE. Dr. Zinn, do you have in mind any reactor concept which, in your opinion, has been developed through its research stages to the point where you feel that it should be exploited and tested out by a prototype model?

Chairman ANDERSON. That is exactly the question I was hoping would be asked.

Dr. ZINN. There are reactor types which, with the same kind of research and development support which is being offered for the reactors in the present demonstration program, could be constructed and would operate as powerplants successfully, I believe. Please understand that the present program, the Shippingport one, the Commonwealth-Edison one, the Yankee Power one, and the Nebraska and all of these require research and development. I believe in some cases the Commission is providing the money. I think that there are other reactor concepts where the same kind of research and development support would produce a reactor that could be constructed and operated successfully. Whether or not it would be as good a bet for economic power, I do not know.

Representative COLE. Is it fair to conclude that those concepts which have not been put into being, into life by these existing programs, are ones less desirable than the ones that have been selected?

Dr. ZINN. By and large that is true. When you say "less desirable," it is what we can understand now would be economic power.

Representative COLE. That is our goal; that is the ultimate goal, is it not?

Dr. ZINN. That may be the ultimate goal. I have heard some statements in the last day or so that our present goal ought to be to get some more large-scale powerplants in existence.

Representative COLE. For the purpose of generating electricity?

Dr. ZINN. For the purpose of demonstrating that we can generate large blocks of nuclear power.

Senator BRICKER. As much as Russia can?

Representative COLE. I do not see the strength of any argument in building a reactor to show you can produce electricity because that is conceded that that can be done.

If the objective of this bill is for the Government to build reactors, for the purpose of generating electricity, irrespective of the economics involved in it, that is an entirely different objective than I understand to be our purpose in this whole reactor development program.

The real objective of this whole thing is to find, as I understand, the most economic and simple and efficient means of generating electricity.

Dr. ZINN. If that is your only goal, then the program of stages outlined by Dr. Davis is a reasonable approach. You take your time, and you test out each concept on experimental reactors, and then on pilot models, and then on prototypes, and you will learn as you go along. It takes a long time.

Senator BRICKER. May I ask a question of the chairman?

Just to clarify my own thinking on the matter, your proposal is to move along about the program as suggested here by Mr. Davis?

Mr. STRAUSS. Yes, sir.

Senator BRICKER. If at any time you reach a point where there is sufficient data to justify what in the judgment of your Commission would be an economic reactor for the production of power if you cannot get that done by private industry and if they do not submit a proposal for it after invitation then you would come to the Congress and suggest that the Commission itself ought to pursue a program of construction to determine the feasibility of that type of reactor?

Mr. STRAUSS. That is right, Senator.

Representative COLE. Would you need to be convinced that this concept is going to be economic?

Mr. STRAUSS. If it approaches economy, and if it makes the same promise that the present types do, we would do that. I think that I also should mention, since the second round has been referred to, which was a proposal that interested parties should come in with projects for smaller reactors less likely to be economic than large ones, that our aim there was to avoid the exclusion of cooperatives and agencies of that sort which generally are in the business of producing fewer kilowatts than the big public utility companies.

We wanted to be sure that we were not showing any preference for one class of power producers as against another.

Senator BRICKER. Maybe I could ask this question of the author of the bill: If this authorization should be made and the Commission should proceed with the construction of one or more of these reactors, uneconomic or whatever you might be able to do, would the preference clause to public authorities and cooperatives still maintain?

Senator GORE. Well, I think that the primary objective is to retain American lead in atomic power? Obviously, the preference clause is in the law of the United States and it would remain unless the Congress changed it.

Senator BRICKER. Unless there was something in your bill to change that application.

Senator GORE. I do not propose to change it, but I would be willing to listen to any arguments for that purpose. That is a secondary matter, I think, but to answer your question, it is the law and I do not propose to change it.

Chairman ANDERSON. Could I come back to the question Congressman Cole asked, and that is the one that I was trying to get around to asking, and which I appreciated him asking.

Before I do so, referring to what Senator Gore had in his statement when he quoted Admiral Strauss a year and a half ago, saying:

> The Commission recognizes that the greatest advances in the actual technology will come from the actual construction and operation of large-scale reactors on a commercial basis. There is no effective substitute for such a practical experience.

A moment ago Congressman Cole phrased it probably better, when he said, "Is there a particular reactor concept that you feel has reached the stage of development," and you modified it to say, if given the same research contributions that the Government is going to give to these other reactors, "it might be a logical and appropriate step for us to take."

Could you give us examples of where you think that there are, perhaps, holes in the present program that profitably could be explored?

Dr. ZINN. I think that there are such examples, and I will not include some very promising things which are now being proposed for the experimental type of construction. What I mean to mention here are types of reactors where we already have considerable experience or where the type of construction and operation does not seem to be of such a novel kind that we could not undertake the construction.

I would then point out that we have many years of experience of operating Hanford-type reactors which are graphite, water-cooled, and that these can be converted or their type can be converted to a power reactor by merely pressurizing the water-cooling channel.

There is an enormous body of experience on large-scale operations. You cannot be sure that the type of reactor does not have as good a chance to be economic with some further development and some construction for power as some of the ones now being constructed.

Chairman ANDERSON. We have quite a bit of experience with that.

Dr. ZINN. We have enormous experience with that type of reactor, not with the tubes pressurized, but that is a technical change that it seems feasible to be able to do. Of course, I would like to point out that the 5,000 kilowatt Russian plant that Senator Gore referred to earlier is just that type. Their larger scale ones are of that type, also.

Similarly, we have enormous experience at Savannah River with a type of reactor which, if it were changed in design to be a pressurized heavy water reactor rather than a nonpressurized one, which it is now, gives as much promise as any heterogeneous-type reactor for economic power, especially if one takes into account that the American Government apparently can produce heavy water at astoundingly low cost, or at least it astounds our friends in other countries.

Chairman ANDERSON. Did you have any contact with the design or operation or construction of the Savannah River plant?

Dr. ZINN. Yes, sir, I believe I had some contact with the design of that plant.

Chairman ANDERSON. Did you design it?

Dr. ZINN. I had something to do with it; yes, sir.

Chairman ANDERSON. You are not unfamiliar with it?

Dr. ZINN. I am not at all unfamiliar with it. I believe there are several versions of heavy water reactors that might be worth pursuing, not only because we have experience with them, but because of all of the high-performance reactors, they are probably as safe as any, and maybe safer, from the hazard point of view. They give the promise, as I mentioned earlier, of giving powerplants which can be operated in large sizes on natural uranium, and if you mentioned an exportable type

of reactor, I believe this is an exportable type of reactor. Remember, it takes with it an important material, heavy water, which is only avaiable commercially, really, in our country. I think such reactors of several kinds, the pressurized-tube kind and also the pressurized-tank type could profitably be developed into a type that has promise for economic power.

Although there has been a great deal of development on the homogeneous, aqueous homogeneous reactor, and although the goals set for this reactor under its present development is really of the very highest type of performance, we have to admit what is lacking in this very attractive type of reactor, from all points of view, economy and safety and so on, is large-scale experience. The homogeneous reactor suffers in comparison with the other types on this count. We know that the Shippingport reactor very likely will operate almost 100 percent of the time, and very successfully, because there is other large-scale similar experience, namely the *Nautilus*, the land-based version of the *Nautilus*, and even our other water-cooled reactors. But the homogeneous reactor lacks large-scale application. It might be wise to undertake a large-scale homogeneous reactor, lowering the performance goal from what is the best we can envision, in order to get an early large plant. By lowering the performance goal, one avoids some of the now technically unsolved problems having to do with corrosion and so on.

Another type which has been passed by several times in an analysis in this country as a power reactor still, perhaps, warrants development and looking into, and that is the gas-cooled reactor. The gas-cooled reactor under any present examination does not give now as good an economic picture as, let us say, a boiling water one would.

Chairman ANDERSON. You mean, for instance, the Zinn boiling water reactor?

Dr. ZINN. Yes, but that carries within it a feature which in the long run may put it ahead. Now, of course, we have heard a lot today about the fact that the British are developing this. The reason that it has promise in the long run is that it takes only some material developments of considerable magnitude to get ractors that operate at really high temperatures. Now, we all know that high temperature in the generation of power is a very useful thing, because it increases the efficiency and the efficiency of conversion of the heat energy in the reactor to electricity. Also, it holds out the promise, perhaps, of some day permitting one to get away from the steam cycle and use the gas cycle. Therefore, to completely ignore this particular development on a large scale might not be the wisest approach, if the opportunity is open for an expanded program.

Finally, I would like to mention that another type of high-temperature reactor, although now in our present program, is in there only in one version proposed, I believe, by one contractor. I speak of the sodium-cooled graphite recator. The reason for using sodium and the reason for giving this type of plant any merit at all is just that it will produce high-temperature steam, high-pressure steam, whereas nearly all of the other reactors previously mentioned, which are based on water technology, do not give high-temperature steam, or high pressure steam.

It may be wise to consider other versions of that particular type of reactor design. That is for large-scale exploitation now.

I do not know whether I have answered your question.

Chairman ANDERSON. You have answered it, and the next question that would come to my mind is this: It would seem that the present program has to be circumscribed by the desires of the people who are going to build the plant. In other words, if they all decided to build pretty much the same type of plant, and the scientists felt that the best way to get it would be through gas, or through the various types you have mentioned, no such proposal would be made to the Commission and therefore that route would never be tried in this country. Would that be a fair assumption?

Dr. ZINN. Well, I believe the present program leaves it up to the proposers to choose, and there is not necessarily any central plan, if I may use that phrase, which may be unpopular. Well, an example of it is that I believe the majority of the reactors being proposed are all light water-cooled and moderated. The emphasis is heavy along that line, and the reason is that everyone has in mind that the *Nautilus* is a fine machine, and that is what that is. It seems to be more attractive to go along that line.

Chairman ANDERSON. So that the determination of what types we will produce is not the determination of the Atomic Energy Commission, but the determination of the electric industry?

Dr. ZINN. I would say it is partly the utility industry, and perhaps even more, the equipment manufacturers. I think the equipment manufacturers have more influence on the choice of what kind of reactor is being developed than anyone else. Maybe that is the way it should be, and I am not saying it should not be.

Representative COLE. Can I conclude from your statement, Mr. Zinn, that with respect to these other concepts that you have indicated, that nothing is being done by way of research or inquiries, or studies on those approaches?

Dr. ZINN. It is not correct to say nothing is being done. I think for every one there is someone who is doing something that would be very useful in that connection. In some cases it actually involves the design and experimental work leading toward such types. In other cases, it is materials research which is being carried out in connection with some other program of the Commission, but the people who are carrying it out and other persons, and observers like myself, can watch it and see when it might develop something that would really fit into one of the things I mentioned.

Representative COLE. You are the author of the expression with respect to the variety of reactor concepts, that it is as numerous as a wagonload of concepts. Now, does the statement which you gave a bit ago, and in which you identified various types of concepts—does that constitute the wagonload? If not, what portion of the wagonload does it constitute?

Dr. ZINN. I do not know that I really ever said that.

Representative COLE. At least you are given credit for having said it.

Dr. ZINN. It does not, of course, represent more than, let us say, a small percentage of the variations of design that one can think of. It is perhaps 10 percent that one could sit down and write out right now. Many of these would be variations of design rather than variations of concepts.

Senator GORE. Mr. Chairman——

Chairman ANDERSON. Is it your opinion from the discussion that has been had of the Russian program and the speech that was made in England a short time ago by the Russian scientist that the Russians are testing several types and making certain bets rather than following the Nautilus pattern all of the way through?

Dr. ZINN. I think the Russians are, if I may say so, operating on the lesson they learned at Geneva. They found out we had a wide variety of programs, and I think that they had research and development in those programs too, because there were papers on this, but they have decided on the basis of these recent speeches to put all of them into construction stages. That is what I think has happened.

Representative HINSHAW. Would the Senator yield to me just a second. I just wanted to point out that there is a new particular item by somebody in Russia, and I cannot remember who, which says that they now have all of the components necessary to put together in a suitable reactor both for production of electric power and for the building of an airplane reactor and a submarine reactor. They have got everything. They are ready to go. That is what they say.

Senator GORE. Mr. Chairman, the reason I asked to make a brief statement is because I have to catch a plane to make a speech on a different subject. It seems to me that the colloquy between yourself and Dr. Zinn, and Congressman Cole and Dr. Zinn, illustrates what I have been trying to get at. I have never questioned the lead of this country in technology. I hope and believe that our technology is far superior. But under the present program, as has so well been illustrated by the answer of Dr. Zinn, we are not exploiting, and we are not pursuing all or even very many of the promising processes and methods, if I may use those nontechnical terms. The control of it is not within, as has been illustrated, the Commission to decide.

Thank you.

Chairman ANDERSON. I think that I can say that I have something of the same feeling that Senator Gore has just now expressed. I feel that the Commission has done a good job in trying to create an atmosphere where the companies will come in and offer to build these experimental plants. I would certainly want to commend the Commission for doing exactly that. On the other hand, it seems to me that the Commission does not get all of the offers that it thinks are necessary. If it feels that there is some point to be gained by trying out a gas-cooled type which the British are tying their program to for a wholly different reason, and I grant that immediately, or which the Russians may be trying, but if a gas-cooled type seems to be desirable and no private company comes long and says that "We would like to put our money into it," then it cannot be done. It may be justified and probably would be very cheap to the American public in the long run if the Commission moved ahead in that field.

Secondly, I think that we have had enough experience at Hanford and at Savannah River so that, as Dr. Zinn has suggested, modification would be reasonably easy to try, and those might offer great possibilities.

If it could happen that they were built in an area either where the Government was in need of power as it may be in the Oak Ridge area or in an area of the country where costs are extremely high and the market is rather active and it could be understood that the build-

ing of the plant does not commit this country to a permanent participation in the generation of electric current, then I think that I would be much interested to try to see if that could not be done.

I am anxious to make it clear that in saying that I am not trying to say that the Atomic Energy Commission has not embarked upon a good program and has not pursued it in a sensible and intelligent way.

Representative HINSHAW. Mr. Chairman, I hope the chairman would not think that the power situation in the Oak Ridge area was a high-cost region. That is the lowest cost that there is in the United States, and so the competition between the two would be the most severe. That is in the Oak Ridge area.

Chairman ANDERSON. I know that, and I know it is very low, but what I was trying to say was that there was an area in which, without getting into a subject we are going to try to keep out of this hearing, there was a controversy about construction of some additional power facilities, and if there might be any shortage of power facilities in an area the Government might build a plant there and mix a small amount of its current with the otherwise very advantageously purchased current.

Representative HINSHAW. You would not raise the total very much, is that right?

Chairman ANDERSON. Well, 100,000 kilowatts, would be 150,000 kilowatts and would take care of the void.

Representative HINSHAW. And $800,000 per year for a mill where you have the cheapest power in the world.

Chairman ANDERSON. I recognize that. And let us say you can have two concepts. I notice General Motors just built a fine research center. They could have stayed with Volkswagen principally, and built the same kind of cars every year for the next 25 years. But it might not have been half as wise for them to build this research center and try to find out if a new type of car would be more advantageous in the years to come. I think that I have to go to vote. Mr. Price will continue the hearing.

Mr. STRAUSS. The question raised in the colloquy between Congressman Cole and Mr. Zinn, of course, relates to technical judgment, as to which concepts for large scale exploitation are there.

The Commission generally, and here I will except the scientific members of the Commission, is in no better position than any member of this committee to exercise technical judgment. We are compelled to rely upon our advisers and technical people. The selection of the reactors which the Commission has made has been based upon an evaluation that way. We receive that advice not only from people employed by the Commission, but from a statutory committee appointed by the President pursuant to the law, of nine distinguished men to whom questions of this sort are referred and with whom they are discussed.

I would certainly not say that we can ever be sure for a generation hence whether the decisions we have made are the sound ones, but they are decisions that we believe to be correct.

Representative VAN ZANDT. Admiral, in an effort to establish the real cost of this program as contained in the Gore bill, you use the figure of $400 million for the cost of the reactor. There is $200 million

for the operation of these plants for 5 years after construction has been completed.

This does not include the cost of construction, operation of the facility, transmission, fuel, and reprocessing, and so forth. Is there any way we could arrive at a figure as to what these items would cost?

Mr. STRAUSS. Would Dr. Davis be able to venture a guess on that?

Mr. DAVIS. One reason we did not try to include any figure was simply the case of fuel element fabrication and processing. We are unable to say whether the Commission would do this or who might do it. If one had to build the complete plant for all of the fuel element fabrication and all of the chemical processing, certainly it would run into the order of at least $100 million, I would guess.

Representative VAN ZANDT. An additional $100 million.

Mr. DAVIS. Something of that order.

Representative VAN ZANDT. That is fuel reprocessing only?

Mr. DAVIS. That includes also fuel refabrication, although this might not be a part.

Representative VAN ZANDT. Would it be proper to say this would probably run between 700 and 800 million dollars for the whole program?

Mr. DAVIS. That is right.

Representative VAN ZANDT. Would you say $100 million for each reactor?

Mr. DAVIS. I believe that is a fair estimate. I should point out that this depends on the size of the reactors that are built, and where they are built. There are a lot of intangibles which cannot be evaluated until you get into such a program. It is simply an order of magnitude figure, but I believe it is the correct order of magnitude.

Representative VAN ZANDT. Then the program, as I see it, could cost $1 billion.

Mr. DAVIS. Yes; it could.

Representative VAN ZANDT. Admiral, what would this do to the companies who are interested in building power reactors?

Mr. STRAUSS. I do not know how to answer that question, Mr. Van Zandt. I do not suppose it would necessarily affect them adversely. They would be able to hold their people in any competition for skills by meeting the market for services. I think that the Commission, on the other hand, would be likely to feel it quite severely.

Representative VAN ZANDT. What about the energy produced? Would it not compete with private utilities?

Mr. STRAUSS. It would depend on the location selected for the plants. One of the difficulties with placing large plants around the country, the site selection, is that this would not be firm power at the outset. These are experimental plants and the power that they would produce, while large for a period of years, would be intermittent. They could, therefore, it seems to me, scarcely be introduced into our economy except in areas of substantial consumption where they would supplement the existing power supplies rather than being the sole source of supply in the area.

Representative COLE. I wish you would develop that point of the intermittency of such reactors. What is the reason why that would be so?

Mr. STRAUSS. Well, the very nature that they are experimental, Mr. Cole, would mean that they would be subject to shutdowns for

various predicted and unpredictable reasons, and that the consumers could not depend upon a consistent flow of power from them until they had ceased to be experimental plants but had in effect become conventional to the extent that we believe atomic energy will become a conventional source of power. That, I think, Dr. Zinn will agree, is still some years off.

Representative VAN ZANDT. To furnish firm power, you would have to give them a conventional type of plant as well as the reactor.

Mr. STRAUSS. If it was in an area where there was going to be a very substantial part of the power produced, something in the nature of standby power would have to be either built or contracted for, produced by conventional means.

Representative PATTERSON. Take an area like New England where it is high cost. What effect would it have there?

Mr. STRAUSS. I do not think anyone feels that any of the plants presently in project or those which Dr. Zinn has mentioned will reduce the cost of power in New England as a result of these installations.

Representative PATTERSON. What effect would it have on Yankee, which has just started?

Mr. STRAUSS. That is an experimental operation, as well.

Representative PRICE. The production from it and all power demonstrations may be intermittent, and there is no way to forecast.

Mr. STRAUSS. That is right.

Representative VAN ZANDT. Could this lead to a Federal atomic power program similar to what we have in the TVA today?

Mr. STRAUSS. Your guess would be as good as mine, Mr. Van Zandt.

Representative COLE. It is becoming more and more apparent that that is involved. When we hear this afternoon that the objective is to generate electricity irrespective of the economics involved.

Representative PRICE. I do not think that statement was made.

Representative COLE. Dr. Zinn indicated that.

Representative PRICE. That was just one thought and it was never verified by the author of the bill. His statement as made to the committee this morning was that the purpose of his bill, or he intended the purpose of the legislation to be to maintain the lead of the United States in an atomic power race. He did not say it was just merely for the purpose of generating power.

Representative COLE. Giving him credit for that being his purpose, and I do, of course, the consequence will be, if the result is to generate electricity and if in doing so it is an intermittent source of electricity, we must build the standby support. If these are to be scattered geographically throughout the country, the conclusion is obvious that the result, irrespective of the purpose, is that we are going to have TVA under the guise of advancing the art of nuclear energy.

Representative PRICE. I do not think the author of the bill intends that. His objective would be the same as the power-demonstration program, to arrive at generation of electricity at an economical figure.

Representative PATTERSON. Would there not be a time element involved when you arrived at such a point where it would be economical, and then it would revert to public utility ownership?

Mr. STRAUSS. There is no provision for that in the bill under consideration, Mr. Patterson. There is another thing that concerns me, and that is plants that are to be built by the Government presumably

on a cost-plus-a-fixed-fee basis will be built like those great installations that the Commission has erected for weapons purposes which are one-time jobs. There is no incentive on the part of the builder to reduce the costs, and the economic incentive for building plants at a lower cost per installed kilowatt is lost. That is a factor, also, in the cost of power. The capital investment in plant has to be amortized over a period of years in the selling price of the energy produced.

Representative COLE. I would like to inquire of Dr. Davis, what productive capacity did you assess or assign to these 6 units, upon which you based a conclusion of a cost of $400 million?

Mr. DAVIS. 1 million kilowatts installed.

Representative VAN ZANDT. I would like to ask Dr. Davis a question. What would that represent, therefore, in the cost of kilowatt construction?

Mr. DAVIS. We estimated this would be something of the order of $250 or $300 a kilowatt of construction, and that the balance would be required for development and components and testing and so on which you have to do with a project of that sort.

Representative VAN ZANDT. That compares with the conventional type of construction of $55?

Mr. DAVIS. It is around $130 for a big modern powerplant of the same size as we would be talking about here.

Representative VAN ZANDT. We would be paying more than twice as much.

Mr. DAVIS. Perhaps 50 to 100 percent more.

Representative VAN ZANDT. Admiral, did I hear you or someone in the Commission say, that after a few years these plants would be uneconomical and would have to be disposed of?

Mr. STRAUSS. I did not say it. It was said.

Chairman ANDERSON. I think we would all concede that the Shippingport plant will not be perhaps as efficient as a new plant after a few years. Probably Consolidated Edison's plant will not be as efficient as a new plant. They may be allowed to wear out, but they will not be as valuable as a plant that is built at the end of the program.

Representative VAN ZANDT. It has meant that we have spent $1 billion in this kilowatt race with Russia.

Chairman ANDERSON. I think he said $400 million.

Representative VAN ZANDT. We added $200 million more and tried to establish the cost of the construction and operation of the auxiliary facility, transmission, and fuel reprocessing and so forth. We arrived at the estimated figure of an overall cost of $1 billion.

Mr. STRAUSS. I would observe, Mr. Chairman, that if we embark on a contest with the Russians to install more electrical kilowatts than they do, and if we believe their estimates, this is not enough because this will provide us with less installed kilowatts by 1960 than they say they will have. If this is to be a national program, it is an insufficient national program to accomplish that end.

Chairman ANDERSON. I will grant that. I would only point out that the question I asked Dr. Zinn had not to do with the kilowatt race with Russia, but whether or not there were some opportunities or some bets that we might not be taking.

Mr. STRAUSS. That is a very important consideration, and, as I say, it is one on which the technicians will have to give us the information.

Chairman ANDERSON. Suppose you decided there was something to this theory about a gas-cooled operation. You have no power to compel Southern California Edison, or any other group to come in and say, "We will build you a gas-cooled type." If the Commission thought it was the finest thing in the world, it has no power to compel anyone to come in and build it.

Mr. STRAUSS. I will explain how that operates. As I said a few moments ago, and as appears in this letter, in the event we failed to obtain industrial sponsorship of such a program, and we thought it had reached the point where it should be undertaken, we would undertake it.

But we do attempt to persuade, with some success, various industrialists.

For example, in one situation, where I think it would be perhaps inappropriate unless you insisted on giving the name, there was a matter in which the contractor did not wish to give the utility involved a performance guaranty and in which the Commission persuaded them that that performance guaranty should be accorded and it was. We are constantly intervening, not in any sense applying pressure, but persuasion in order to advance the program. That is done with some success.

Chairman ANDERSON. But you said if the types looked promising, and private industry did not do it, you would feel that you might ask for authorization.

Mr. STRAUSS. That is right.

Chairman ANDERSON. Now, surely the Savannah River type is promising, and why have you not asked for authorization?

Mr. STRAUSS. It has been represented here today as promising for this purpose, but the Reactor Development Division of the Commission has not come to the Commission with any such recommendation.

Chairman ANDERSON. Then do I understand that you do not think that the Savannah reactors have any possibility for the economical development of power?

Mr. DAVIS. Well, I do not believe that we have said that. What we have said is that we feel that the other types on which we are working show a greater promise and to the extent we have limited resources in terms of people and manpower and laboratories, we have tried to put our effort on those types that are the most promising.

Chairman ANDERSON. Then it is limitation of resources that has you tied up?

Mr. STRAUSS. We could not take the whole wagonload, Senator.

Mr. DAVIS. I believe that we would certainly try a good portion of those to try to speed up the development of those types which we think are most promising, and namely those on which we are working.

Chairman ANDERSON. Now then, you think the types on which you are working are the most promising?

Mr. DAVIS. That is correct.

Chairman ANDERSON. What is there in the history of those types that gives you more experience than you have had at Hanford and Savannah River?

Mr. DAVIS. Well, the experience at Hanford and Savannah River is on production reactors which are basically low temperature reactors, on which to some extent, by virtue of the fact that we do know the costs of these and we do know the operating costs of them, we feel that the types we are working on show greater promise. On these at least we can say we think that we know pretty well what the costs are. The others we think that we cannot prove the costs will be lower but we believe they will be.

Chairman ANDERSON. You are familiar, I know, with the speech that Kurchatov made. He referred to the gas-cooled type, and Britain is going to a gas-cooled type. Is it your conviction that they are absolutely in the wrong alley?

Mr. DAVIS. No, sir. There are a number of reasons why countries may choose different types of reactors. In the first place, there is the incentive in some areas to use natural uranium. This depends to a great extent upon the price of heavy water and the price of enriched uranium. In this country we have a low price for both of these things.

We do not have any great incentive to use natural uranium when enriched uranium can be used and it is cheap.

In the gas-cooled reactor, I believe Kurchatov was talking about a gas-cooled heavy water reactor and not a gas-cooled graphite reactor. This is an interesting type, and one on which, again, we have not made any very detailed evaluations that I know of, and we have not so far concluded that this is a particularly interesting type.

I might add that we are continually carrying out studies and investigations of new types of reactors, and we are doing some work today on a power reactor of a gas-cooled type. This is directed toward the use of small units, with a closed cycle gas turbine and it is not an application for large sizes. We are continually exploring ways of utilizing new combinations of coolants, and moderators, and fuels to try to come up with things that we think give promise.

Chairman ANDERSON. Getting you over to what Congressman Hinshaw was talking about, to try to carry some of these things to other countries, do you not believe that some of these other countries would be a little bit more interested in natural uranium than in the enriched uranium? The article which the Chairman read into the record had to do with that very subject.

Representative HINSHAW. The article that the Chairman read into the record pointed out that the natural uranium-graphite thing was so out-of-date that they could not export it.

Chairman ANDERSON. This is so out-of-date that Russia hopes to start building one now. Dr. Zinn thinks that it may have some possibilities.

Mr. DAVIS. Could I say this, that in recent months we have given considerable thought to the necessity for proceeding along the lines of reactors which would utilize natural uranium and heavy water. In fact, we have had some discussions with Dr. Zinn in his capacity as Director of Argonne as to the possibility of using heavy water in an experimental boiling water reactor, and this is an approach which we would like to follow.

Chairman ANDERSON. If we find some private utility does not want to build that, do we abandon the program? That is a question, Mr. Chairman.

Mr. STRAUSS. If it is ready for large-scale production, and there is no commercial interest, private utility or public utility in the sense of cooperatives willing to go ahead with it, then we would certainly consider doing it ourselves.

Mr. DAVIS. The point is that they are still in very much of an exploratory stage, and they are not at a point where we would feel ourselves or industry would appropriately go into the construction of this kind of a reactor. I might observe in connection with the application of the water-graphite reactor to the production of power that we were asked when this proposal was made to underwrite something of the order of $10 million in research and development in order to make the simple application of this reactor to a power-producing reactor. That is a large amount of money for research and development, and it is comparable to the amount we are spending on the same kinds of things for these other concepts.

They apparently did not feel this was simply a job of making this application.

Representative PATTERSON. After the conclusion of the experiment, what were you going to do with the reactors? Were you going to sell them to public utilities or junk them or what?

Mr. DAVIS. These would probably be either revamped, or torn down. As you know, in the case of the homogeneous reactor, we have taken out the original reactor, and replaced that now with a second reactor in the same bedding, and we have plans later on to convert that to more advanced types.

Many of these experiments will go through this kind of thing, and you put new cores in and you have more concepts for experimental facilities.

Chairman ANDERSON. Now, you mentioned this $10 million and $15 million that was too much for research. Give us the figure on research of the Shippingport reactor.

Mr. DAVIS. The total research on the Shippingport reactor is roughly $50 million.

Chairman ANDERSON. It was not too much for Duquesne, was it?

Mr. DAVIS. Duquesne is not paying this.

Chairman ANDERSON. I know they are not paying it. You do not have to tell me that. They even got a tax writeoff on the part that they are paying for, which is just a generating station. It is all right to put $50 million into Duquesne, and what would be wrong to put a few million dollars into testing out what we have operating at Hanford or what we have operating at Savannah River.

Mr. DAVIS. $10 million is only on research. I would have no objection to spending $10 million to do this if we felt it was the best use of $10 million.

Chairman ANDERSON. You felt $50 million for the reactor to produce current at 52 mills is better than spending $10 million on something that might produce it for 10 mills.

Representative HINSHAW. Shippingport is the first reactor that was built.

Chairman ANDERSON. I am trying to find out why you thought $50 million at Shippingport to get 52-mill electricity was better than spending maybe $10 million in the hope of getting 10-mill electricity.

Mr. DAVIS. The objective was to build a full-scale reactor at Shippingport.

Chairman ANDERSON. One of these would be full scale, would it not?

Mr. DAVIS. It would be. This is the decision that was made 3 years ago, and at that time it was not even known what the power costs would be for the Shippingport reactor, although it was estimated that it would be quite high. We still believe that the pressurized water-reactor has some promise of getting down to fairly low power costs some day.

Chairman ANDERSON. The main thing seems to be that these tie back into the fact that equipment manufacturers built something for the Nautilus, and therefore, everything has to fall into that pattern for a long time thereafter.

Mr. DAVIS. I do not think so. We are certainly not trying to follow that.

Mr. STRAUSS. I submit, Mr. Chairman, that the amounts spent in connection with the Shippingport plant has to be prorated over all plants that are operated on that principle.

Chairman ANDERSON. Precisely, and if you spent $10 million on this other plant, you would have to prorate that.

Mr. STRAUSS. To apply it all to the prototype would be unfair. One might go back and say that applicable to Shippingport is the research that went into the *Nautilus* reactor.

Chairman ANDERSON. We are not doing that, though.

Mr. STRAUSS. A part of the technology in the Shippingport reactor is identical with that of the *Nautilus* reactor.

Chairman ANDERSON. But that is not part of the $50 million.

Mr. STRAUSS. No, but I am pointing out that the prototype will always, until it is divided or the number of plants are divided into the development cost, appear to have occasioned a very high expense.

Chairman ANDERSON. If we would take the Savannah River and Hanford technology, and try to build a power reactor you surely would not charge against that all of the reserach that was put into the building of gaseous diffusion plants and everything else, would you?

Mr. STRAUSS. No.

Chairman ANDERSON. Then why worry about the research on a lot of this? We are not trying to charge this to Shippingport. It has no relation to the *Nautilus*. You are not charging it within the development cost of the *Nautilus*, are you?

Mr. DAVIS. No; this is development cost over and above that.

Chairman ANDERSON. What about the Yankee project? Is there not some research in that?

Mr. DAVIS. About $5 million of AEC-supported research is going into the Yankee proposal.

Chairman ANDERSON. Is that all?

Mr. DAVIS. Yes, but this would be, again illustrating Mr. Strauss' point, that they only are able to get this because there has been $50 million spent on the PWR.

Mr. STRAUSS. The amount diminishes with the amount of plants built on a principle.

Chairman ANDERSON. If you spent this $10 million you are talking about, it might start diminishing after a while.

Mr. STRAUSS. That is right, sir.

Chairman ANDERSON. I have asked too many questions, I feel. Are there any further questions?

Senator JACKSON. I wonder if we could have in the record, if it has not already been placed in the record, the breakdown of expenditures on Shippingport. As I understand it, the Duquesne Power & Light Co. are paying for the conventional power features, the generators and so on.

Chairman ANDERSON. Plus about $5 million.

Mr. STRAUSS. As I understand it, it is as follows: The Duquesne Co. initially provides the site. They build at their own expense all of the conventional generating equipment. They contribute to the Government $5 million towards the reactor. They pay for the operating expenses of the entire plant, their end of it and our end of it. The Westinghouse Co. contributes its profits, which they have estimated at half a million dollars, and the Duquesne Light Co. agreed to buy the heat generated for a period, I do not know how long that, is for 3 mills per kilowatt-hour in excess of the fair cost of production by conventional means.

Chairman ANDERSON. Could we then pick up the question that Congressman Hinshaw raised a minute ago, where he took each mill, and figured it worth $800,000 a year. Now, this is a 100,000-kilowatt plant.

Mr. STRAUSS. This is rated at 60,000, and we hope it will produce 90,000.

Senator JACKSON. Could we get the investment of the Commission or the Government in the facility, just to complete the record?

Mr. DAVIS. I can give it roughly, and I believe the committee has the detailed figures, or we could supply them again. But the cost of the plant itself, the nuclear portion of the plant, is listed at $37½ million, of which $10 million is for the first core. This will be replaced periodically and it is not basically a part of the permanent part of the plant. The other $27½ million is $5 million from Duquesne and the balance of 22½ by ourselves.

Senator JACKSON. And the nonnuclear part will be borne by the Duquesne Power & Light Co.

Mr. DAVIS. That is something of the order of $10 million, although I do not have the precise figure.

Senator JACKSON. It is conventional and there is nothing unusual about it.

Mr. DAVIS. Not in the sense it is a very low pressure saturated steam turbogenerator and it is not the kind of a plant that you would build for a modern conventional power plant by any means.

Senator JACKSON. Is it more expensive?

Mr. DAVIS. It is more expensive in dollars per kilowatt, I believe.

Mr. STRAUSS. They could not use it elsewhere.

Chairman ANDERSON. I would like to come back to Mr. Hinshaw's calculations. He was showing the horrors of the Gore bill by showing that each mill was going to cost us $800,000 a year. Now, we will take your figure that this is going to be 90,000 kilowatts then, and so nine-tenths of $800,000 a year or seven-hundred-and-some-odd-thousand dollars a year for each mill. The mills are going to be 52 mills cost on it, which is 40 mills above normal cost, so we multiply 700,000 by 40 to find out how much the Government loses on Shippingport each year. Would that be a fair way to do it? That is 28 million dollars a year.

Mr. DAVIS. Excuse me. The 52 mills includes in the writing off the equivalent writeoff of portions of the plant so the actual operating cost is not as high as 52 mills.

Chairman ANDERSON. They do not have money in the plant.

Mr. DAVIS. The 52 mills comes by considering the total cost of the plant and assuming that we are going to write it off. This is not an actual cost but the equivalent cost if the plant were built and written off in the normal way.

Chairman ANDERSON. Do I understand that the figure we have been given on the cost of it to show it was high cost power includes some other things that the Government does not ordinarly do. Does the Government write off ordinarly the cost of its investment in the *Nautilus?*

Mr. DAVIS. No.

Chairman ANDERSON. Where do you get the 52 mills? How much is the operating cost going to be?

Forget the writeoff now. I am trying to find out how much it is going to be per year. That was the argument against the Gore bill, that it was going to cost some money.

Mr. DAVIS. We might look first at the cost of the core itself, which is the largest part of the cost. Now, this first core which will go into the PWR, which is now being built, if that core lasts only for the length of time that it has been anticipated to last, then the cost on that basis of that core alone is 39 mills.

Chairman ANDERSON. As a practical business operation, if you think your plant is going to wear out in a specific number of years, you have to charge that into the rate.

Mr. DAVIS. But I think the point is here that we would expect the second core to have something like twice the life, and also to be cheaper.

Chairman ANDERSON. And Congress might never put up the money for another core after they get through examining this deal. But in any event, all you know now is it is going to be 52 mills because you are going to have to write off that core or some other core at that rate or some other rate. I am trying to figure out what you multiply it by now. What is the difference in cost?

Mr. DAVIS. The 39 mills would be the cost of the core. The balance of 13 mills would be the equivalent cost of writing off the cost of the plant and would include something of the order of 2 mills per kilowatt-hour for the operators or the natural physical operations of the plant.

Chairman ANDERSON. Well, the Duquesne power has been given a fast writeoff on their part of it. Does that figure in the rate?

Mr. DAVIS. I am sorry, Senator. This 52 mills is arrived at on the basis that some industrial company, or some utility would build a plant which had the same capacity and cost the same total number of dollars and it would be written off on a conventional utility plant basis.

Chairman ANDERSON. I am trying to get some way of comparing this. Mr. Hinshaw had an argument against the Gore bill and we have had this 52 mill rate for 10 months, so far as I know. Now I want to take that 52 mills and translate it into the annual cost, and it is not a firm figure now. What is the firm figure?

Mr. DAVIS. I think the actual cost you could use would be 40 mills for the first year, let us say, and our estimated operation during the

first year is only a fraction of the full-time operation that Mr. Hinshaw assumed. Actually we estimated that the plant might not be in operation because of its experimental nature more than a small fraction.

Chairman ANDERSON. That raises the cost of current that much more, and the less it operates the higher the per kilowatt cost of the energy.

Mr. DAVIS. It decreases the cost to the Commission in any case, so you would not add this up as an annual cost of doing this.

Chairman ANDERSON. They are going to build it and then not run it?

Mr. DAVIS. They are going to build it and run it to the maximum extent that they can.

Chairman ANDERSON. Why do you give me the figure of 90,000 now if they are not going to be able to run it at 90,000? What will they be able to run it at?

Mr. STRAUSS. In that period of years, and not at that time.

Mr. DAVIS. During the early years it will run at its maximum capacity for as much time as it can.

Chairman ANDERSON. What do you think that might be?

Mr. DAVIS. I believe that perhaps if one assumed that it would run half of the time, 60,000 kilowatts in the first year, this would be fairly optimistic.

Chairman ANDERSON. Well, I will take 60,000. It is $480,000 per mill and you are going to lose 40 mills. That is $20 million a year. Would that be a fair figure?

Mr. DAVIS. I think that is a little high at least for what we have planned for covering the operating expenses.

Chairman ANDERSON. Is there anything that we can get that will be helpful?

Mr. DAVIS. We will try and supply you with one. If you judge all of these things by the spread in mills, it is going to be a difficult thing. I do not want to do it on Shippingport because I still think that the Commission did a good thing in trying to get large-scale reactor in operation.

(The information referred to follows:)

ATOMIC ENERGY COMMISSION,
Washington, D. C., June 19, 1956.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: When Mr. W. Kenneth Davis testified before your committee on May 23, 1956, he agreed to furnish you with a breakdown of data showing the method and assumptions used in calculating the expected cost of power from the Shippingport plant (PWR) which was used at the PWR information forum of December 2, 1955, at Pittsburgh. This information is attached herewith. (See table, next page.)

It should be recognized that the attached calculations are based on arbitrary assumptions and estimated costs as set forth. Different assumptions would, of course, produce different final figures.

I trust that the attached material provides the information you desire.

Sincerely yours,

K. E. FIELDS, *General Manager.*

Pressurized water reactor economic data

	Case A	Case B	Case C
Cost of plant and 1st core	$37,750,000 total budget estimate of PWR and 1st core, not including TG plant built by Duquesne Light Co.	Budgetary contingencies eliminated. Assumes better core performance.	New plant. Same design and drawings (no design charges). Procurement with proven design and specifications.
Capital investment, includes:			
Design and engineering	$9,000,000	$9,000,000	0.
Plant construction	$27,000,000 [1]	$24,000,000	$19,000,000.
TG portion	$9,000,000	$9,000,000	$9,000,000.
Total	$45,000,000	$42,000,000	$28,000,000.
Fixed annual charge	14 percent	14 percent	14 percent.
Plant capability	60,000 EKW expected during initial operation.	9C,000 EKW based on improved core performance.	90,000 EKW.
Core life (estimated)	7,600 hours for 1 blanket and 2 seeds	7,600 hours for 1 blanket and 2 seeds	11,750 hours assumes much longer core life.
Plant factor	80 percent	80 percent	80 percent.
I. Investment Cost	15 mills/kwh Calculation: $\frac{14\times45{,}000{,}000\times1{,}000 \text{ mills}}{365\times24\times0.8\times60{,}000} = \frac{15 \text{ mills}}{\text{kwh}}$	9 mills/kwh	6 mills/kwh.
Estimated cost of core	$11,000,000 estimated (one blanket, one seed).	$14,000,000 (one blanket, two seeds)	$4,000,000. Based on greatly improved manufacturing techniques.
II. Fuel charges	$18,000,000	$22,000,000	$9,000,000.
Includes:			
Fabrication cost		$7,000,000	$2,000,000.
1st core	$5,000,000 [1]		
Replacement seed	$1,000,000		
Nuclear materials	$3,000,000	$5,000,000	$4,000,000.
Other materials		$7,000,000	$2,000,000.
1st core	$6,000,000 [1]		
Replacement seed	$1,000,000		
Inventory charges	$2,000,000	$3,000,000	$1,000,000.
Total	$18,000,000	$22,000,000	$9,000,000.
	=39 mills/kwh Calculation: $\frac{18{,}000{,}000\times1000 \text{ mills}}{7600\times60{,}000} = \frac{39 \text{ mills}}{\text{kwh}}$	=32 mills/kwh	=9 mills/kwh.
III. Operating and maintenance cost	3 mills/kwh based on Duquesne experience. 129-man crew and high maintenance during early operation.	2 mills/kwh based on improved operation.	1 mill/kwh based on improved operation.
IV. Credits	−5 mills/kwh based on estimated value of unburned fuel less cost of reprocessing.	−4 mills/kwh based on value of unburned fuel available for reclamation less cost of reprocessing.	−2 mills/kwh based on less fuel left to recover.
V. Total	52 mills/kwh	39 mills/kwh	14/mills/kwh.

[1] 27,000,000+5,000,000+6,000,000=38,000,000 (budget estimate rounded off).

Mr. STRAUSS. There is one fundamental difference. The Shippingport plant was built for experience, and to gain a first operating reactor. It was not built to compete in a kilowatt race. That is the fundamental difference between this project and the thing we are discussing here.

Representative COLE. There is a much more fundamental difference based on what information is given to us. I assume that Shippingport was the one selected by the technical experts as being the most promising and the most economical. Now, the best that the scientists could find is one with a cost of 52 mills, and we will accept that.

Now, the Gore proposal, which I am not sure I understand the chairman of the Joint Committee is supporting, would require expenditures in which the spread would be a cost of not 50 mills but 150.

Chairman ANDERSON. I do not think anyone has talked even remotely about 150 mills. The testimony has been that they can come down to 10 or 12 mills on this. That is what I understood we were interested in.

Representative COLE. On what?

Chairman ANDERSON. By taking the Hanford plant and adapting it to power instead of plutonium or the Savannah River plant. I am trying to differentiate between what I had in my mind and what is in the Gore bill, which is different. I do believe that if the Shippingport is a desirable step and there are other desirable operations that have not yet been tested, it might be worth while to get them into this even though we might do it by expansion of the existing powers of the Commission.

Mr. DAVIS. Mr. Chairman, I would like to make one statement on that.

Chairman ANDERSON. I am afraid I have to go and vote.

Mr. DAVIS. The Shippingport reactor was chosen at that time as being a promising type of reactor, which was the only type that could be built full-scale starting in 1953.

Chairman ANDERSON. It was not selected for its low cost of operation, because I remember Dr. Davis and others explaining that it was going to be a high-cost operation, and I felt it was very much worthwhile to try even if it was a high-cost operation.

Representative COLE. Let me make sure that I am correct, that the concept used at Shippingport is not one selected by the scientists because it appeared the most promising from the standpoint of economics.

Mr. DAVIS. No.

Representative COLE. Why was it selected?

Mr. DAVIS. It was selected because it was felt that it was the only type on which there was sufficient experience at that time to proceed with the construction of a full-scale plant with assurance that it could be built and that it would work.

Representative COLE. Why was it selected initially then, which resulted in providing the Commission with the greatest experience?

Mr. DAVIS. At that time we had experience with the Mark I of the *Nautilus* reactor, at Idaho, and because we were at that point well along in the construction of the reactor for the *Nautilus*, and because we had had experience with water-cooled reactors and such things as the MGR type and things of that nature. We felt that we had a good background in pressurized water technology of various sorts.

Representative COLE. Economics was not involved in the selection of the reactor type for the *Nautilus*.

Mr. DAVIS. The problem of designing a reactor for a submarine is quite considerably different in this respect, although economics has some effect on it, but the basic requirement there is to get a low weight and a little space reactor. That is not required in a commercial one. The pressurized water reactor has a real advantage for a compact reactor, but not necessarily for a cheap reactor.

Representative COLE. Well, then, economics as well as space and weight considerations entered into the decision of selecting the *Nautilus* reactor.

Mr. DAVIS. I believe the *Nautilus* was selected again at that time as being a reactor for submarine application. We felt that it was feasible to stay within the limitations of space.

Dr. ZINN. Economics was not really considered in selecting the *Nautilus* plant. It was space and weight entirely, and horsepower, of course.

Mr. STRAUSS. And safety of operation.

Representative COLE. Has the chairman made up his mind on his position with respect to the Gore bill?

Chairman ANDERSON. No.

Representative COLE. Then you are not in a position to answer the question I was about to propound to you. I will make an observation of the confusion in my mind. I think we all approve of the expressed purpose of the Gore bill and that is to find out as much about atomic reactors as possible. But as I see the picture, about 4 or 5 years ago the Atomic Energy Commission with some assistance and some needling from those of us who were anxious to get along, started out on a 5-year reactor program for this purpose. It was for testing out these various concepts. After that, the Commission on its own initiative embarked on a supplemental reactor-development program. The door was open for that route by the change in the law. The private operators were invited in.

Presumably, for the selection of the types for the 5-year reactor program, I think it is a fair assumption that the most promising types were selected by the best scientific talent that the Commission could engage. Thereafter, with the reactor development program which capital was participating in, presumably those people engaged the best scientific brains that they could engage and the decision made by those companies was of the most promising types of reactors that our technical people could conceive. There are some 12 or 14 in that area, of different types or modifications of reactor concepts. Therefore, it seems to me that if the Congress through the Gore bill requires the Commission to go beyond that at an estimated approximate eventual cost of 300 or 700 or 800 million dollars, the Congress will be requiring the expenditure of that sum of money on projects which, with all due respect to Dr. Zinn, are projects which the scientific people feel to be the least promising.

Chairman ANDERSON. I do not believe I could subscribe to that. I do not believe that the scientific people had anything to do with the selection by Commonwealth Edison, and Consolidated Edison and Detroit Electric and Yankee of the types they were going ahead with, and the Commission did not have anything to do with it.

Representative COLE. I assume they are sensible people and they went out and hired scientists to look into all of these various concepts and relied upon the recommendation of their employed scientists. I assume that that is what they did.

Chairman ANDERSON. I do not argue that, but I assume they picked out the thing that was going to cost them the least money in the long run, as they saw it. Now, it just could be that a wholly different idea tried out might work. I have illustrated that many times by the automobile industry, where Mr. Knight invented the Knight-type motor and he had a chance to sell it to almost every large manufacturer, but he wanted 51 percent of all of the companies. Because he could not get 51 percent control, the automobile companies threw the Knight-type motor over and went to a wholly different type of motor which they perfected, and it has developed into a wonderful thing. Heaven only knows what would have happened if they had tested a different type motor.

It just could be that when Russia and Britain get through, it will be found that they have a right type. It might be better than something we have. It is a matter we do not go into, but we know when we started to develop the hydrogen bomb, we took one route that would have been fantastically expensive, and it was the right thing to do, and I would not question it in the slightest. But by mere chance we found out something else was much better and we abandoned something that was about to cost $450 million that would have had to be thrown away the first year after it was finished.

Now, those things happen in this business, and it could be that something else would prove to be usable.

Representative COLE. I have always had great reliance on the ability of falling back on the independent judgment of the General Advisory Committee. I was not here when they made their presentation yesterday. I understand that the net of it was that the G. A. C. has no serious disagreement with the current reactor program, and they do not look favorably on this suggestion of Senator Gore, and among other reasons they fear the dislocation and confusion that would be caused in the scientific personnel by the scarcity of scientific personnel.

So, much as I am anxious to get along about the program, I think we have to justify a recommendation to the Congress and I cannot very well see my way yet to recommend an expenditure of that amount of money on projects which scientific people indicate to be not promising or to be not as promising as the ones that we are now working on.

Chairman ANDERSON. Well, that is true if you take the point of view that the things that these private companies have decided to build are the things that the scientific community and the Atomic Energy Commission has decided are the only things that should be built. But if you take the point of view that the Commission ought to have a right to try a few other things even if the shareholders of some of the large companies may not think they are the most promising, then I think that you might come to a conclusion that you would ask the Commission to undertake certain specified types which they might be willing to recommend as highly desirable. I think there might be a middle ground, Mr. Cole, between the proposal of the Gore bill, and the language of the present bill which is somewhat restricted and limits the Commission to those things that the stockholders of Commonwealth

Edison, Consolidated Edison, and Detroit Electric feel to be immediately promising and not too expensive for them.

Representative COLE. Let me ask Mr. Strauss this question: If the Commission had $100 million on its conference table down there at the Commission's offices, is there any reactor project which you feel has sufficient promise and of a novel concept which would in the opinion of the Commission justify the expenditure of $100 million?

Mr. STRAUSS. It would have to be determined in terms not only of money but of available manpower. The bill, Mr. Chairman, is not a permissive bill. It is a direction.

Chairman ANDERSON. I would hope that Congressman Cole's question was searching for a middle ground that maybe he and I might find or that someone else might find.

Mr. STRAUSS. I think one could say this, that if we had a very large sum of money and a relatively unlimited supply of manpower, it would be our desire to explore concepts that were second and third and fourth down the line of attractiveness.

Representative COLE. Is there any concept that the Commission knows of now which it feels has sufficient promise that the Commission is not advancing because of the lack of funds?

Mr. STRAUS. I do not know of any.

Chairman ANDERSON. You do not think the gas-cooled one is worth testing?

Mr. STRAUSS. There, Mr. Chairman, I would have to say that my inadequacy as a technician would not entitle me to answer that question.

Chairman ANDERSON. Your answer to Mr. Cole's question was based on that.

Mr. STRAUSS. Since we have not the money or the manpower at the moment, we are not testing it except that we are conducting an experimental work on a number of the projects which have been mentioned. The reactor has been mentioned and we are building at the present time and it is in an advanced stage of completion, the second of a series of models.

Chairman ANDERSON. Do you not think it is quite promising?

Mr. STRAUSS. Yes; and I would say that it would have to operate before it would seem to me advantageous to build a full-scale reactor.

Chairman ANDERSON. But the plans is, if it does operate, and all of the money is spent on it, then Pennsylvania Power & Light is to build it. Always the Government spends the money on the research and gets it ready for them, and turns it over and it is impossible for us to go ahead with it and try to find out if the operation will be successful. I do not object to Pennsylvania coming in and building it after some work is done. But we have to wait such a long time before they are willing to take the tests.

Mr. STRAUSS. They integrate it into a distribution system with standby power available. If it were at the stage where we could justify building it, all of the other considerations which have been mentioned here, that is to say, the provisions of a suitable site, to provide suitable distribution of the power, to provide standby power, would have to be taken care of by the Commission or by the Government.

Chairman ANDERSON. Would it be a fair assumption then that the power reactor development program is for the purpose of making sure

that we have reactors ready for private industry to use and that the research cost of those will be borne by the Federal Government?

Mr. STRAUSS. That, in general, is the philosophy of the Commission. If for private industry you will substitute "private industry or cooperative power companies," that is true. We have not attempted to limit our assistance to private industry in the sense of industry owned by individuals or shareholders.

Mr. DAVIS. I think it would be fair to point out that Pennsylvania Power & Light Co. are spending a very substantial sum of money on their own development program, leading toward this.

Chairman ANDERSON. Is there much compared with what the Government is spending? I did not gather from their testimony that it was.

Mr. DAVIS. It is quite a substantial amount, and this is their own research and development program which is being coordinated with the work we are doing at Oak Ridge. So they are not simply waiting for us to complete the research and development before they go ahead.

Chairman ANDERSON. I am not hostile to that, and I am very glad they are spending the money and I am glad that we are getting something ready that will be usable by them.

Mr. STRAUSS. The knowledge becomes generally available, Senator.

Chairman ANDERSON. I cannot get out of my mind the fact that manpower is not such an awful handicap when the people who get into the guided missile field just go broadside and hire everybody that comes along as fast as they can hire them without regard to anything.

Mr. STRAUSS. There is one fundamental difference. They do their research by contract. We do our research in Government laboratories, and to a great extent have limitations that are not experienced in some other areas of research because of the fact that there are almost inevitably classification problems involved.

I think in view of the fact that Dr. Libby and Mr. Vance are here, and that I have monopolized the testimony to such an extent, if they have anything to say they could present it.

Chairman ANDERSON. Mr. Vance and Dr. Libby know that we are ready to have them chip in from the rough any time they wish and come in with any conversation or discussion. Do you have a supplementary statement that you would like to make or any comments on what has been going on? We would be very happy to have them.

Dr. LIBBY. I think that this discussion today has pretty thoroughly covered the subject. Perhaps there is one point which I think might be added.

We are in a contest to develop an economic atomic power industry and it seems to me more important than the money matter is the technical manpower. Every major kind of a technical achievement is traceable to one or two men, or a small group of men. These men are scarce.

Now by and large they are in the employ of industry or the universities. In a technical development of this sort they are in industry.

So as I see the problem, it is one of making arrangements so that we have the best chance of getting the people who are capable and interested enough to push it through. That is to solve the essential and difficult problems.

Now, I believe that in time of peace it is difficult with the cost-plus type of contract to get a contractor to put these precious people who are in his employ, who are the people who are making the new developments in his own technology which increases his company's profits, and to get them to put them on a cost-plus type of job.

I believe that an arrangement of partnership with industry which insures that they have some of their own money and substance in the project is the one which assures us the best chance of getting the ablest people in their employ on our atomic power problem.

I think with this point the record has all of the things I have in mind. I am very sympathetic to some of the projects that Dr. Zinn mentioned, particularly the homogeneous reactor, and we should look through all of these things and when they look to be sufficiently promising go right ahead with them one way or another. But remember, the critical thing is going to be whether we can get the man on the job who can do it.

Chairman ANDERSON. This is outside of your realm, and it is a question that you can ignore, but do you think that in the guided-missile program when they recently picked several different firms to start different types of work, the determining influence was whether or not the manpower existed or whether or not we were in a race with Russia and needed to try every available angle?

Dr. LIBBY. I am not informed of the details, but I think that there is more analogy in the guided-missile program with our program during the war. You see, during the war we got along with cost-plus contracts because people were working at it for patriotic reasons, and they threw in their best people and they did everything that they could. I think the guided-missile program is more in that category than our atomic power development program is.

Chairman ANDERSON. But if you wanted to develop a new type of reactor, let us say the homogeneous type, could not you do it by contract equally as well as you can operate Oak Ridge by contract or Los Alamos by contract?

Dr. LIBBY. This is a good example. In my mind, the homogeneous reactor will have to be developed with a chemical company at least involved in it, for many of the problems are problems which the chemical companies are accustomed to solving. I am pleased to know that Carbide & Carbon are associated with Pennsylvania Power & Light in this venture on the homogeneous reactor. It is absolutely essential.

Now the answer to your question is whether we can get a chemical company to put the 2 or 3 men, the keymen, on that job.

Chairman ANDERSON. They will do it for Pennsylvania Power & Light, but will not do it for the Atomic Energy Commission?

Dr. LIBBY. I would say that when their own money is involved, they are a little more likely to do it.

Chairman ANDERSON. You think their own money will be involved in Pennsylvania Power & Light?

Dr. LIBBY. I do not know the contractual details, but, in general, on these partnership arrangements the companies' money is involved.

Chairman ANDERSON. If the Atomic Energy Commission asked Carbon & Carbide to go ahead with that type of reactor and build it so that the Government would have an opportunity to put 100,000 kilowatts on the line down at Oak Ridge where there is still a power shortage, what would be so out of step to do that?

Dr. LIBBY. What I think we should do is try the other route first and see if we can get them to do it on the partnership basis. As the chairman has said, then we can try the other thing. We will go ahead with Government money.

But try the other route first, because I think this is a better chance of their putting the extremely able men, who are necessary for these difficult jobs, on the job.

Chairman ANDERSON. It will come more slowly, several years more slowly.

Dr. LIBBY. I think that you all know how unique Dr. Zinn's contributions have been in the heterogeneous reactor field. I think you all know of Admiral Rickover's contribution in the submarine.

Chairman ANDERSON. Do you not suppose either one of them can build it in a short time if you turned them loose and said, "We want it."

Dr. LIBBY. They are certainly the kind of people we need.

Chairman ANDERSON. It is the kind of people that we are not going to get if we leave it to the private utilities to go ahead with.

Dr. LIBBY. Most of them are employed by industry.

Senator PASTORE. Could I ask Dr. Libby a question? Are you honestly and seriously satisfied with the progress that has been made by private industry thus far since the passage of the 1954 law?

Dr. LIBBY. I think that it is very encouraging, and I think that it will increase in the future, and I think that we should expect that it will. I would be happier if there had not just one type of homogeneous but two. I must say to you, I am a little biased, being a chemist, and I sort of favor the chemistry kind of thing. However, it is a personal bias. I think this one is a good bet, the homogeneous reactor is a good bet.

Chairman ANDERSON. You cannot get it now. Even if the Commission was unanimously in favor of doing it, you could not do it. Even if every member of this Commission wanted to do it, you would have to stand by, and wait until private industry got ready, and that is what we are trying to do.

Mr. STRAUSS. How is that?

Chairman ANDERSON. Can you go ahead and build one tomorrow?

Mr. STRAUSS. No.

Chairman ANDERSON. You are barred by the law.

Mr. STRAUSS. We could come to Congress for the authority.

Chairman ANDERSON. You have to wait until Pennsylvania Power & Light is ready.

Mr. STRAUSS. It seems to us that that will produce just as rapidly. Incidentially, with respect to the progress that has been made since the 1954 act, Senator Pastore, it has not been 2 years since that act became the law of the land. I think if you will look at the number of reactors building, and on the drawing boards and in negotiation with the Commission, the conclusion is inescapable that an enormous amount of progress has been made in a very short time.

There has been no technical breakthrough. The Commission has been in existence 10 years, and I think the progress within the last 18 or 20 months has been quite remarkable.

Senator PASTORE. The reason I bring up this subject is that in your opening remarks for the Commission this morning, you went on

to state the purpose of the 1954 law. One of the objectives to promote world peace, and I think what we have in mind is the spirit of the remarks that President Eisenhower made before the United Nations in 1953, when he talked about the international agency.

Many of us are impressed of course, with this idea. If somehow we can share this knowledge and the bounty thereof with some of the underprivileged nations of the world, we might thereby remove the causes of war and stimulate an attitude that would activate peace.

Now, naturally, of course, that is the foreign policy objective of the Nation. That cannot be the immediate concern of a group of stockholders or members of a board of directors. After all, while it is a desirable goal, and they would like to lend themselves toward the accomplishment of it, the fact of the matter still remains that is fundamentally a governmental responsibility in which they share of course as individual citizens.

However, their chief concern, of course, is the economics involved in this problem, as you well know, as a businessman. They cannot get into a venture and put up a large part of their money. First of all, they are not going to receive some kind of concession as to whether or not it will be considered research funds as operating costs, or what have you.

Naturally, you would not expect the impetus or the drive that would come from a Government that is interested in this international panorama that we have been talking about.

Now, that being the case, and realizing the fact that we are in competition with Russia and France and the United Kingdom, it strikes me that because of these deterrents or these roadblocks or whatever you want to call them, there seems to be a need here for at least surveillance on the part of the Government that at least the spirit continues of the 1954 law.

Now, with that as a background, of course, we heard a statement made by a prominent member of those firms. I asked him the question at one of the hearings, and I said, "You were very optimistic at the time you were asking us to pass the 1954 law, and now you appear to be cautions?"

He very wisely answered me, and it was wise, "Well, afterall, we think of electricity in terms of this nuclear power, in terms of auxiliary current."

There is not the necessity and the need. We know that apart from the auxiliary part of it, the use that the American consumer will make of this, we are thinking in these broad terms of world peace.

Now, wrapping that all up together, do you still feel that private industry is doing all that it can, and that we are all doing all that we can. We talk about giving, let us say, 20,000 kilograms of uranium or selling it. It is not worth anything unless you have some reactor to put it into to burn it and make current.

Now, we are talking about 20,000 kilograms. Whom are we kidding? Where are we going to burn this 20,000? The important thing here is the reactor. Are we satisfied with that campaign and that program?

Mr. STRAUSS. I think I can demonstrate to you that what Congress has done has had just the effect that you wished to see accomplished. The fact that Duquesne and Westinghouse are building the plant at

Shippingport made it possible for the Belgians to order that type of reactor. In other words, it was an assured type of reactor. The fact that Westinghouse had had experience in building it enabled them to give the Belgians a guarantee of performance. That would be the first reactor to ever be sold by any country to a foreign country, and it will be the first one to participate in this 20,000 kilograms.

Chairman ANDERSON. Has it been sold?

Mr. STRAUSS. It has been sold.

Chairman ANDERSON. On an official contract?

Mr. STRAUSS. Yes, sir.

Chairman ANDERSON. Well, has the Belgian Government been insisting that it have liability insurance? The testimony in the hearing the other day was that they would like to have us expand our act to have liability insurance to take care of the reactor in Belgium, and the liability insurance question might raise some problems over there.

Mr. STRAUSS. This is not known to me, Senator.

Senator PASTORE. I think the argument was made that the suppliers raised the point as to whether or not there would be indemnity in case of any injury and I do not think that the question was raised by the Belgian Government.

I think what they are going to do is negotiate that exemption between the Belgian Government and the supplier. We do that on our bilaterals too, and I think Mr. Cole raised the same question on the bilaterals.

Mr. STRAUSS. As chairman of the subcommittee dealing with these matters, there will be reported to you a number of negotiations currently being carried on by the Commission with other countries for power reactors. My understanding is that three research reactors have been sold, or is the figure four?

Mr. DAVIS. It is three.

Mr. STRAUSS. This business is in its infancy, and it has just begun.

Representative COLE. I would like to make sure, if it is the fact, that in all of our bilateral agreements there is a provision requiring the other government to indemnify us and our American suppliers against liability for public damage.

Mr. STRAUSS. It did not exist in the early bilaterals. The question was raised by Senator Pastore, I believe, and Mr. Cole at a meeting some months ago. Can you tell us, Mr. Mitchell, whether any language has been incorporated in bilaterals executed subsequent to that?

Mr. MITCHELL. We are now incorporating such a provision, and it is not by way of indemnity, but disclaimer. In other words, the other government recognizes that it has a responsibility. It is not in terms of passing on money claims, but rather a recognition that our Government is not responsible for what happens in the other country. We are doing this in all of our bilaterals now, and when we come to any amendments of existing bilaterals, we are also inserting it in those.

Representative COLE. Is that provision contained in the Belgian agreement?

Mr. MITCHELL. I believe not. This point came up after the Belgian agreement was executed, but if we should come to the point of amending the Belgian agreement, then of course, we will put it in there.

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Senator PASTORE. Not only that, but in leasing the material you are going to have it in that agreement?

Mr. MITCHELL. Yes.

Senator PASTORE. When you lease the material, where it does not exist in the bilateral, we have the assurance from the Commission that they will insist that that waver of liability affecting America will be included in the leasing agreement?

Mr. MITCHELL. Yes, sir.

Mr. STRAUSS. My memory is refreshed, and the question was raised in connection with the discussion of the Belgian power bilateral, before your subcommittee.

Mr. MITCHELL. We did include such a provision in our lease of the fuel to the Swiss.

Representative COLE. Does this provision deny the foreign citizen or the foreign claimant, the person who may be injured, or damaged, the right of pressing a claim against the American supplier?

Mr. MITCHELL. It is not written in terms of operating on the domestic law in the other country. What it does say, is that the other government assumes responsibility.

Representative COLE. Well, that does not entirely, I would not think, satisfy Westinghouse.

Senator PASTORE. Oh, yes, it does.

Dr. ZINN. There is one point. Westinghouse is providing the reactor but the Belgian company which is getting the reactor is providing the safety container and the housing and making all of the provisions in connection with the reactor housing. They have been over to consult with us on this.

In other words, the job has been separated, and the safety of the environs is apparently the responsibility of the country and in design and construction. Westinghouse is just providing the reactor. That may cover the situation.

Chairman ANDERSON. The Research and Development Subcommittee in 1954, in March of 1954, turned in a report on the 5-year reactor development program and referring to the pressurized water reactor, it said:

> The pressurized water reactor might also contribute substantially to carrying out the President's international cooperation proposal. It uses as fuel uranium slightly enriched in the isotope-235. With relatively minor redesign it would operate on natural uranium if heavy water were to be used as a coolant and moderator instead of natural water. Plants of this type could be built in foreign countries with United States assistance at an earlier date than the more novel plants using highly enriched fuels. Thus we believe electric power could be provided at competitive prices in many parts of the world in the next 10 years. Later on, as technology improves, possibly more efficient reactors, using enriched fuels, could also be made available.
>
> As a demonstration of the serious intent of the United States to develop peacetime uses of atomic energy for both ourselves and our allies and as a tool to help gain operating experience on a full-scale plant, the continuation of construction of one large-scale plant such as the pressurized water reactor is important.

Now, if we had taken that reactor, and adapted it as was suggested here, it might be more quickly available to these countries and that is my main concern in this, that we try to find ways of adapting this which I think we will be more likely to do if it were the responsibility of the Atomic Energy Commission, and if it was the responsibility of private industry as is now contemplated.

Mr. STRAUSS. On that date we had no authority even to export natural uranium.

Chairman ANDERSON. It was Mr. Hinshaw's report, and undoubtedly, it was what he referred to.

Mr. Vance, do you have anything to add?

Mr. VANCE. I do not think I can make any worthwhile contributions to what has been said here today.

Chairman ANDERSON. We appreciate you being here.

Mr. STRAUSS. I would like to thank the committee for its patience in listening to us.

Chairman ANDERSON. I think it has been a very very helpful meeting.

Thank you, gentlemen.

When the statement is received from Commissioner Murray we will insert it at this point.

(Commissioner Murray's statement follows:)

STATEMENT OF COMMISSIONER THOMAS E. MURRAY, UNITED STATES ATOMIC ENERGY COMMISSION, SUBMITTED TO THE JOINT COMMITTEE ON ATOMIC ENERGY JUNE 18, 1956

My views on a national policy for the development of industrial atomic power are importantly influenced by the ever-increasing threat of nuclear weapons to the continued existence of mankind. Echoing a warning which I previously voiced, a recent report by a group of outstanding scientists notes the possibility that the detonation of enough of these weapons could render the entire earth, or a large portion of it, uninhabitable.

I have on prior occasions before your committee endeavored to demonstrate the relationship between this threat and our atomic-power program. Once again, however, the dimensions of this danger were impressed on my conscience as I recently witnessed a nuclear explosion in the far Pacific. The possible implications for man's future, so vividly illustrated, compel me again to urge the acceleration of this Nation's progress in the field of peacetime power reactors.

The present prospect of getting any substantial quantity of industrial atomic power in this country by 1960 is very gloomy—and getting more gloomy every day. At the root of the matter is the fact that the Government has prematurely abdicated to private industry the primary responsibility for building large power reactors. Under our present policies, with one notable exception, the Commission's activities in the field of large power reactors are confined to research and development, small-scale pilot-plant construction, and limited assistance to participants under the power demonstration program.

Our immediate national effort in the field of large-scale power-reactor construction is limited to this demonstration program as supplemented by other activities under the licensing provisions of the Atomic Energy Act. Thus our progress is in the greater part based upon decisions by either participants or licensees as to what type of reactors to construct and at what time to begin constructing them.

Under these procedures four basically different large-scale reactor types are being explored. Some of these reactor types have now come to be accepted as the domain of an individual company or group of companies. For example, the Detroit Edison group is identified with the fast breeder reactor; North American with the sodium graphite reactor; and Commonwealth Edison and its associates with the boiling reactor. Yet the public is given the impression of a massive attack toward industrial nuclear power carried forward by private industry on each sector of the front. Let us examine the situation more closely to determine how rapidly this massive attack is advancing.

The fast breeder reactor area has been staked out by Detroit Edison and its associates. In addition to the many technical obstacles involved in this project, there are other difficulties cited as barriers to progress. Unless the problems relating to third-party liability insurance and exemptions from the Public Utility Company Holding Act are solved in a manner satisfactory to the Detroit Edison group, the project is not likely to get beyond the initial stages.

Another technical area that has been staked out is that of the sodium graphite reactor. North American Aviation plans to construct a full-scale reactor of this type rated at 75,000 kilowatts for the Consumers Public Power District of Nebraska. However, this project is contingent upon obtaining satisfactory results from the operation of a small experimental reactor now under construction. In my opinion, these results will not be known until 1958. Thus we are faced with a possible delay of 2 years before a decision is made as to whether or not to construct this important type of power reactor. Moreover, there is a serious question whether a public power group can afford to take the financial risks inherent in this project.

Yankee Atomic Electric Co. presently plans to construct a large reactor of the pressurized water type. Under a contract with Yankee, the Commission has agreed to provide certain financial and other support for this project. However, the contract does not establish any date for completion; neither does it provide any penalty for withdrawal. It does have a provision that the contract may be modified by the parties to provide for a different reactor or design in the event that estimated power costs substantially exceed the original estimates on which the proposal is based.

In addition to the reactor types represented by these projects there is another class of considerable importance, namely, aqueous homogeneous reactors. Pennsylvania Power & Light has announced its intention to build a reactor of this class for operation in 1962. However, actual construction is contingent on prior proof that construction would be economically justified. This contingency casts grave doubt on the projected completion date of 1962. This project, of such a tentative nature, is the only plan which contemplates constructing a large-size homogeneous reactor.

There are those who believe that our present program is an adequate one. In support of this view the argument is advanced that our efforts are sufficient to enable us to remain ahead of the Soviets. To my mind, however, our program should not be paced solely on estimates of what the Soviets and other nations are doing or intend to do in the power reactor field. Nor should we allow ourselves to become embroiled in arguments over estimates that are made of Soviet capabilities, and so permit such arguments to become the basis for delay. What is required is that we recognize the need for action and that we take this action unilaterally and independently of the actions of other nations.

Right action should follow if we recognize the central fact that the development of industrial atomic power is not a matter of choice, but of necessity. Electric power is the very life blood of nations and the hope of the have-not countries. The upward trend in world population, the accelerated industrialization of underdeveloped areas, and the progressively growing per capita utilization of energy all imply increasing requirements for electric power. On the other hand, there is a limit on the amount of conventional fuels which will be available. Nuclear fuels will be required to meet the increasing demand.

Already in certain areas abroad fuel shortages are beginning to appear, notably among the highly industrialized nations of Western Europe and in Japan. In such countries imported fuels are being used to supplement dwindling fuel reserves. For example, in the case of Western Europe the total net expenditures for fuel imports have been estimated as between $1.5 billion and $2 billion for 1955, and these are expected to increase to $5 billion by 1975. The problem of fuel shortages in Japan was one of the considerations that led me in 1954 to propose the construction of a large power reactor in Japan.

The United Kingdom has abandoned the idea that coal and oil can meet her expanding requirements for electric energy and has undertaken the active development of atomic electric power as a matter of national policy. The goal of its program is to develop this new source of power so as to provide a major portion of Britain's electric energy requirements as soon as possible. Concretely it envisages building a large number of power stations with an installed capacity of 1½ million or more kilowatts by 1965.

We should recognize, of course, that such a program will place the United Kingdom in an excellent position to export large power reactors. Mr. R. N. Millar, manager, atomic energy department of the General Electric Co., Ltd., puts the case quite forthrightly in these words: "In Britain the emphasis is on large central stations * * *. When the export drive gets underway it will be backed by sound practical experience in a large home market, an advantage which will not be shared by America."

What the atomic power pattern will be in underdeveloped countries is difficult to discern in detail. It will depend in part on our willingness to aid these

countries in answer to their pleas for improved standards of living. Yet the needs of these countries for electric power is beyond question. One has only to realize that the present per capita consumption of electricity in the United States is 600 times that in Haiti and 200 times that in Ceylon to understand the differences in the respective standards of living which these figures imply and the serious problems involved.

It is appropriate to ask how the electric energy needs of these countries will be met. Where conventional fuels are inaccessible or otherwise unavailable the clear answer will be through nuclear power. In other cases conventional fuels will present a solution under present economic conditions. But looking beyond the present it will be evident in many cases that conventional fuels alone cannot form a stable basis to meet long-term needs. Nuclear power, however, can furnish long-term solutions. Sound planning indicates that such nations must begin now to integrate nuclear power into their economy. We should be prepared to assist them.

If action is not forthcoming to break the monopoly now enjoyed by private industry in the large industrial reactor program, we will not be prepared. It is evident to me that without such action the only significant amount of electric power that will be available in this country in 1960 will the kilowatts coming from the Shippingport plant, the construction of which is largely being financed by the Government.

On February 23, 1956, I proposed that we adopt a national policy which treats the development of industrial atomic power as a matter of urgency. I made certain recommendations as to how this policy should be implemented. One of these recommendations was that we establish a goal of 2 million kilowatts for the construction of power reactors, here and abroad, between now and 1960.

It is important to emphasize the significance and importance of goals. Adoption of a goal, simply and forthrightly stated, has, in my experience, been the sure way and the practical way to give direction to a complex program. It has the merit of bringing order into all the diverse efforts involved. It becomes the practical gage against which progress is measured. Intelligently used, it becomes the spur to achievement.

This has been already significantly demonstrated in our own atomic-energy program, where I insisted on raising our goals to bring about a revolutionary improvement in ore procurement. This experience encouraged me to attack the industrial nuclear power problem in the same way; that is, by recommending the establishing of goals in terms of kilowatts.

I also recommended last February that the Government assume the primary responsibility for meeting the objectives I suggested for the period between now and 1960. Consistent with this proposal I now urge that the Government undertake to construct several large power reactors.

One of these reactors should be an enlarged and improved version of the pressurized-water reactor now being constructed at Shippingport. All the valuable lessons learned and extensive experience acquired in the course of developing and constructing this plant would be incorporated. An expansion of effort of this kind is required if the United States is to take the greatest advantage of its progress in this field. There is, for example, the need to enlarge our capabilities for testing the new and improved core designs for this type of reactor. Since the first core of the Shippingport plant will last approximately 2 years, the loading of an improved core at Shippingport will not take place until 1959. Another facility would advance the testing of new core concepts.

The Government should build one large-size aqueous-homogeneous reactor. As I have previously indicated there are at the present no firm plans for constructing a large reactor of this variety. I recommend that the Government step into this gap. Unless such a project is instituted the homogeneous reactor is destined to remain in the research and development stage for many years to come.

There are other areas of reactor technology which have received relatively little attention in our programs. One is the gas-cooled reactor; another is the natural-uranium reactor. There are several variants of both types. I would propose to build a large-scale plant of each of these kinds of reactors along whatever lines hold promise of the greatest contribution to nuclear power.

An important consideration in constructing these reactors is the manner of disposing of the power they produce. My recommendation is that they be placed at the sites of our production facilities, which today require a capacity of about 7 million kilowatts. Such tremendous electric power requirements could well absorb the output of these reactors with only barely discernible effect on the cost of weapons. Moreover, the small contribution of atomic power to the total de-

mand would make it possible to carry out experimental operation of these reactors without affecting production of weapons materials.

Construction of a large-scale sodium-graphite reactor in the near future presents a different problem. To solve it I propose an approach that differs in detail, but not in principle. Concretely I would have the Government assume the responsibility for building a large-scale reactor of this type. It could be located in Nebraska and the power made available to the Consumers Public Power district. North American Aviation would continue to develop and construct the plant. Such a plan would permit research and development to be stepped up from its present inadequate level. This is the only way that I can see to bring this reactor into operation at an early date.

Taken together these proposals for constructing large reactors constitute a well-integrated program with two exceptions. They do not guarantee sufficient progress on the boiling-water reactor and the fast-breeder reactor. Both require more extensive investigation. Without specifying the precise method it suffices to say that the Government must insure that construction of such reactors goes ahead.

It is, of course, easy to conjure up reasons for not undertaking such a program as I propose. There is always the appealing alternate of convening committees and task forces to formulate arguments for inaction. One such argument is that it would result in an unjustifiable drain on the Nation's limited supply of scientific and engineering manpower. I do not subscribe to this argument. Far from decreasing the numbers of those trained in reactor technology a program of building reactors should act to increase them. There is no way of training competent reactor engineers that is comparable to designing and building reactors. A predominant effect of a large and assured program of reactor construction would be an increase in the numbers of those attracted to the reactor engineering field.

There are many reasons why private industry should favor the Government's undertaking the program that I have outlined. A first consequence of such an effort would be that the Government would bring its immense resources to bear in eliminating the technical obstacles that are now impeding private industry's program. This would react to decrease the cost and increase the likelihood of success of private industry's plans to construct large reactors. The resulting progress would assure for American manufacturers a place in the world market for industrial power reactors.

In addition, a Government program of the scope proposed would not only provide an assured base for the construction of large power reactors but would also serve to increase overall industry participation in the atomic energy field. It would, for example, encourage private industry to undertake to provide services such as fabrication and chemical processing of reactor fuels.

Private industry needs the assistance which a Government program of large reactor construction would give. Yet the view prevails that private industry is prepared to undertake the crucial and costly phase of reactor development which large-scale construction represents. The prevalence of this view derives from the fact that atomic power has been oversold. Millions of people have been given the impression that electricity from the atom is just around the corner. However, our knowledge is so meager that, in the absence of an accelerated program, the corner is 10, 15, or more years away. Such an accelerated program will not be forthcoming as long as we rely on our present policies which make the economics of nuclear power in the United States the consideration governing progress.

It is a tragic mistake for this Nation to base its atomic-power program primarily on our own economic interests. To do this is to fail to recognize the vast political and humanitarian implications of atomic energy throughout the world. It is to follow a course which is at variance with our own larger interests, and more importantly, with all that this Nation stands for.

The fact that we are taking this course is the result of fear; fear by private industry that Government will enter the power business as a consequence of its accelerating development through power reactor construction. Such fears are unwarranted; they cannot rightly be countenanced as cause for delay.

Acceleration of reactor development by the Government will not jeopardize the role of private industry in power production. Irrespective of who develops it, when industrial atomic power becomes available, the Government can use it to produce electricity, should it so desire. In this respect nuclear power does not differ from power which is produced from conventional fuels.

The traditional role of private industry in the production of electric power must be preserved. But private industry is not helped by an artificial argument which seeks to preserve industrial atomic power as private industry's domain at the expense of the national interest as well as its own particular interests.

It requires no great powers of discernment to understand what the national interest requires in the development of atomic power. One has only to view the problem in the light of already massive and constantly growing proportions of the threat from developments in nuclear weapons. Had representatives of private uindustry stood with me and watched a recent nuclear explosion, I am confident that they would recognize the nuclear threat to civilization. I am further confident that they would endorse the most urgent measures to accelerate the development of industrial atomic power.

It is the urgent need for action of this type which causes me to submit this statement to your committee. I have read many statements assuring you that our industrial atomic power program is adequate. My responsibility compels me to alert you, as I have on other occasions, to the fact that I can give you no such assurance.

I believe that our present program will not enable us to fulfill our responsibilities with respect to the early development of industrial atomic power. The Commission must continue its basic research and development activities as well as continue its support to private industry under the power demonstration program. However, if we are to keep our repeated and widely publicized promises to make available the benefits of atomic power to mankind at an early date we must do more. The only way I know to discharge our responsibilities and redeem our pledges is for the Government to assume the primary responsibility for large reactor construction. In order to do this I strongly recommend that Congress enact legislation similar to that proposed by Senator Albert Gore and Congressman Chet Holifield. This legislation should provide for a program of large power reactor construction generally along the lines I have proposed and at the locations I have suggested.

Chairman ANDERSON. We will now adjourn.

(Whereupon, at 5:10 p. m., Wednesday, May 23, 1956, the Joint Committee on Atomic Energy recessed, to reconvene at 10 a. m., Thursday, May 24, 1956.)

ACCELERATING CIVILIAN REACTOR PROGRAM

THURSDAY, MAY 24, 1956

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D. C.

The joint committee met at 10 a. m., pursuant to recess, in the caucus room, Senate Office Building, Senator Clinton P. Anderson (chairman of the Joint Committee) presiding.

Present: Senators Anderson, Pastore, Gore, and Bricker; Representative Van Zandt.

Present also: James T. Ramey, executive director, George Norris, Jr., George E. Brown, Jr., Wayne P. Brobeck, and David R. Toll, of the Joint Committee staff.

Senator JACKSON (presiding). The committee will come to order.

The first scheduled witness was Senator Wayne Morse. He has been delayed and will be here a little later. If there is no objection, we will proceed to the next witness, Mr. Wilbur E. Kelley, president of the Walter Kidde Nuclear Laboratories, Inc., representing the National Association of Manufacturers.

Mr. Kelley, we are delighted to have you here. I believe you are the former manager of the New York office for the Atomic Energy Commission, the Operations Office.

STATEMENT OF W. E. KELLEY, PRESIDENT, WALTER KIDDE NUCLEAR LABORATORIES, INC., ON BEHALF OF NATIONAL ASSOCIATION OF MANUFACTURERS

Mr. KELLEY. Yes, sir, for some years I managed the New York office for the Commission.

Senator JACKSON. We will certainly be pleased to have your statement. You may proceed in your own way.

Mr. KELLEY. All right, sir.

Mr. Chairman, my name is Wilbur E. Kelley. I am president of the Walter Kidde Nuclear Laboratories, Inc., and am testifying today on behalf of the National Association of Manufacturers.

As I am sure you know, the NAM is a voluntary organization of approximately 21,000 members, representing a wide cross-section of American industry. Many of the member companies are participating in the peacetime nuclear energy program within the limits of existing laws and regulations.

In fact, the NAM and its membership has considered the development of nuclear energy peacetime applications of sufficient importance that the Board of Directors recently authorized the establish-

ment of a Nuclear Energy Committee to take the place of special subcommittees of the Research and Patents Committees which have been studying problems in this field for several years. This new committee held its first meeting on May 4 of this year.

The bill under consideration, S. 2725, would authorize and direct the Atomic Energy Commission to construct six nuclear power facilities for the production of electric power. Each facility would be of a different design and located in six different geographical areas. It is intended "to demonstrate the practical value of utilization facilities for industrial facilities or commercial purposes" pursuant to the Atomic Energy Act of 1954.

This proposal thus seems to indicate that private industry has not proceeded as rapidly as possible with its research and development in this area.

We believe that the Atomic Energy Act of 1954 has been beneficial to the Government, the public, and American industry by permitting private companies to participate in the development of peacetime uses of nuclear energy.

In the field of power development, industry has responded to the opportunity with 15 power reactor demonstration proposals to the Atomic Energy Commission, designed to establish a sound, economic technological basis for a nuclear power industry competitive with other types of power generation systems.

These proposals represent nine different types of reactors: pressurized water, boiling water, sodium graphite, fast breeder, organic moderated, aqueous homogeneous, liquid metal fuel, gas-cooled and sodium-cooled, heavy water moderated.

A total of $309 million of private funds are called for in this program as against about $55 million of Government funds. Five of the proposals represent completely independent industrial programs, totaling $199 million. Those proposals total about 1.1 million kilowatts of installed electricity capacity, of which 675,000 kilowatts will be provided entirely by private funds.

The Atomic Energy Act of 1954 was pasesd in August 1954; the proposals from industry were submitted to the AEC as early as March 1955, with the latest ones submitted early in 1956. However, the first construction permits issued by the AEC were released in May 1956, and only three have been issued thus far.

Therefore, it appears that industry has demonstrated and is continuing to demonstrate a willingness to invest considerable sums of money in long-term research and development aspects of power generation from nuclear energy plants. It is certainly assuming a substantial portion of the risks in achieving the goal of economical power from nuclear energy.

This is a highly desirable situation and closely follows the sense of Congress, as expressed by the Joint Committee on Atomic Energy during hearings before passage of the 1954 act that:

> * * * the goal of atomic power at competitive prices will be reached more quickly if private enterprise, using private funds, is now encouraged to play a far larger role in the development of atomic power than is permitted under existing legislation.
>
> In particular, we do not believe that any developmental program carried out solely under governmental auspices, no matter how efficient it may be, can substitute for the cost-cutitng and other incentives of free competitive enterprise.

Senator GORE. That is a rather interesting statement. You say no matter how efficient it may be. You still would not like to see it?

Mr. KELLEY. Sir, I am quoting from the hearings prior to the passage of the 1954 act. This is not my statement, sir. However, I would endorse the general sense of it.

Senator GORE. In other words, that is your view today, too?

Mr. KELLEY. Yes, sir; it is.

Senator GORE. All right. We understand each other.

Mr. KELLY. In our opinion, enactment of this bill would reverse the intent of Congress as expressed in the 1954 Atomic Energy Act; it would not accelerate sound long-term development of electric energy from nuclear power; nor would it assist the "qualitative" development of nuclear reactors, but instead, would concentrate on "quantity" development.

The Geneva Conference on Peaceful Uses of Atomic Energy in August 1955 indicated that the United States has leadership in the development of nuclear technology. However, the question has been raised as to whether or not we are maintaining this leadership in view of the extensive program underway in Great Britain and the reported 5-year program in Russia.

It seems to me that we must stop and examine just what we mean by "leadership" in this case, and also just what the foreign programs are.

Admittedly, Great Britain has embarked on a large-scale reactor-construction program, which even so will not be completed before 1965. This program is designed to overcome serious shortages in England of conventional sources of power. The reactor designs are limited in kind, the great majority being of one type.

The British may well construct a greater number of reactors by 1965, but their technological knowledge will not be as highly advanced as that in the United States. Furthermore, there is a distinct possibility that the chosen design may prove to be uneconomic.

Sir Edwin Plowden, head of Britain's Atomic Energy Authority, recently stated during his visit to the United States that Britain is very short of coal and oil, with no natural gas; so there is an urgent need for power. He added that the cost of producing nuclear power is not the deterring factor that it is in the United States.

The Russian program is harder to assess. Apparently it is a 5-year plan which is broader in scope than the British one, but not as broad as the power reactor demonstration program in the Unite States, broad in the tenchnological sense. The Russians have indicated that the total capacity of the atomic power stations will be around 2 to 2½ million kilowatts.

It is difficult to understand just what is this "leadership" we are losing to other countries. The present United States power-demonstration proposals of private industry will lead to a more sound—in my opinion, sir—to a more sound, technological development than under the British or Soviet programs.

The problem should not be looked at purely from a quantity point of view; it appears to us that when nuclear power becomes economic, the quantities in terms of plants and generating capacity will take care of themselves. Private American economy has never yet failed in any race for expanded industrial capacity.

Under the power-demonstration program, operation of certain of the reactors will begin in 1957; others will go into operation in the

succeeding 5 years. This is as rapidly as can be expected. Even if S. 2725 were enacted into law in the immediate future, it would doubtless be at least 3 years before any of the reactors were put into operation. Doubtless certain of the reactor types under consideration now both by industry and Government would prove uneconomical and obsolete by the time of their completion, but this is the cost of good research and the price of true progress.

However, under the private power demonstration program, the Shippingport pressurized water reactor being built by Westinghouse Electric Corp. and Duquesne Light Co. under Atomic Energy Commission contract, with the majority of funds coming from the Government, is taking 3 years from the breaking of ground to operation.

However, under the private power demonstration program, the taxpayer would be required to pay relatively little of the costs of the uneconomic plants. On the other hand, under the terms of S. 2725, the taxpayer would bear the brunt of the cost of the construction of the plants, some of which likewise would be uneconomical and obsolete by the time of their completion.

In addition to the financial considerations involved in connection with S. 2725, there is also the important factor of the scientific, technological, and engineering talent which would be necessary to put such a program into operation. The scientists, technicians, and engineers trained in the field of nuclear energy are today all engaged in working in the field; none of these persons are looking for employment these days, at least to my knowledge.

Therefore, enactment of S. 2725 would most certainly result in a diversion of this talent from the more comprehensive industrial and scientific programs currently underway and this diversion would appear to be unnecessary and wasteful. The United States can less afford to waste its scientific and technological manpower than almost any other of our resources.

A final point—and a most important and fundamental one, in my opinion—concerns the development of sources of electric power by private competitive enterprise or by the Federal Government.

We believe that the Government's responsibilities should not include competition with its own citizens. The NAM board of directors has approved a policy which states, in part, as follows:

> We believe that the production and distribution of electric energy to the general public is in no sense a responsibility of the Federal Government. We further believe that developments by investor-owned electric companies are in keeping with the principles of the private-enterprise system as opposed to Federal controls which inevitably follow the nationalization of energy resources.

The reactors envisaged under S. 2725 would be public property and the power generated from them, public power. Aside from the inherent disadvantages of Federal intervention in the field of power generation and distribution, I think it is a generally accepted fact that the United States does not, at present, need these additional nuclear power generation facilities, although there may be a growing need for new——

Senator JACKSON. Your statement as given in the printed text is completely false, because there is an obvious need for additional power facilities. The need for power in the United States is doubling every 10 years, Mr. Kelley; I am sure you are aware of that.

I am glad you put nuclear power in there because the statement as given to the press, of course, is at complete variance of the position of the private utilities and the National Association of Manufacturers.

Mr. KELLEY. And with my personal position, Mr. Chairman. I discovered this in rereading the original draft of the statement.

I am certainly aware of the growing snowballing need for new installed capacity.

Senator JACKSON. It has been doubling every 10 years and less than 10 years in the early stages of it.

Mr. KELLEY. I am merely stating my reservations that our immediate need is for this new power as nuclear power. I feel that by waiting for further development, the completion of some of our technical studies now underway, that we will come to new designs that will prove truly economical.

In conclusion, therefore, we recommend a continuation of industry's proposed program. Industry has proposed construction of nine different prototype power reactors. Those types were determined after consideration of the large number of possible designs; these designs are considered the ones most likely to succeed by persons trained in the field, and the ones most likely to lead to a technological advance in the power reactor art.

This art is a changing one and needs technological research and development before it can be considered satisfactory for large-scale exploitation. Construction permits for three power reactors have been issued:

(1) Consolidated Edison Co. for a 150,000-kilowatt reactor to be in operation in 1960;

(2) Commonwealth Edison Co. for a 180,000-kilowatt reactor to be in operation in 1960; and

(3) General Electric Co. for a prototype reactor to be in operation in 1957 or 1958.

Other groups will begin work just as soon as AEC construction permits are issued. This entire program represents solid demonstration by private enterprise of its willingness to proceed as rapidly as appears technologically sound.

We urge that S. 2725 not be favorably reported in its present form by the Joint Committee on Atomic Energy.

Thank you, Mr. Chairman.

Senator JACKSON. Do you feel, Mr. Kelley, that the private companies will be able to reach that goal?

Mr. KELLEY. Yes, sir. I have no reservations about the ability of private companies to design and construct these reactors, but as I mentioned in my prepared statement, I feel that to go beyond this at this time may be an extreme burden on the private companies insofar as their technical staffs are concerned.

Senator JACKSON. However, is it not a fact that the state of the art at the present time is such that unless there is a subsidy by the Government either direct or indirect, you cannot produce competitive economically feasible power at this time?

Mr. KELLEY. That does seem to be the result of most of the studies that have been made to date.

Senator JACKSON. So that the head of any private utility is going to be confronted with that fact in trying to sell his stockholders on the idea of going into the power business in an area where the costs are

going to be well out of line with either the use of hydro power or conventional fuels; isn't that a fact?

Mr. KELLEY. For the immediate future, that certainly seems to be the fact.

Senator JACKSON. At least as far as we can foresee at the present time, unless the art is improved or unless there is the accomplishment of controlled thermonuclear energy?

Mr. KELLEY. That is certainly correct, sir.

Senator JACKSON. So what we are really talking about is, it does seem to me, whether we are going to subsidize private industry in this field or if we are going to have Government participate in that subsidy along with private industry.

The Gore proposal does not preclude private industry at all. It merely suggests that these various types of reactors be developmental in nature rather than an attempt to get into the nuclear power business; isn't that true?

It is to aid private enterprise, as I understand it. I read your quotation up there. I agree with it completely. On top of page 3 you quote from the report, I believe, on the bill.

Mr. KELLEY. Yes, sir.

Senator JACKSON. You say in the last line:

> In particular, we do not believe that any developmental program carried out solely under governmental auspices, no matter how efficient it may be, can substitute for the cost-cutting and other incentives of free competitive enterprise.

What is there in the Gore bill that is inconsistent with that statement?

Mr. KELLEY. My position is that to force the design and construction of additional nuclear plants at this time can only result in the duplication of designs that are now being planned.

Senator JACKSON. I don't think that follows at all. The record of the hearings, Mr. Kelley, indicate that at the present time the Commission has no control nor would they attempt to exercise control over the proposals as to a type of reactor submitted by a private company.

If it is left entirely at the present time to private companies to do the job exclusively, then the variety that you refer to, variety of developments, will not necessarily take place. Isn't that a fact?

Mr. KELLEY. Sir, there are nine different designs being proposed today. Those designs are believed by many technically competent people to be——

Senator JACKSON. Did you hear Dr. Zinn's testimony yesterday?

Mr. KELLEY. No, sir; I did not.

Senator JACKSON. Who is highly qualified, you will agree.

Mr. KELLEY. I agree that Dr. Zinn is an eminent man in this field.

Senator JACKSON. He indicated that so far all of the proposals that have been submitted by the private companies follow one particular design, I believe.

Senator GORE. Pattern.

Senator JACKSON. One pattern. The variety that you refer to doesn't seem to be coming forward, according to Dr. Zinn. I believe that is the testimony.

I think his testimony was that they tend to concentrate on water reactors. Of course, Senator Gore can speak for himself on this, but Senator Gore's proposal is to aid private industry to get the variety

that we need of approaches so that we can come up with the most feasible type of reactor and get low-cost power.

That is what we are all working for and we want to get there as fast as possible and the only way, Mr. Kelley, that you are going to get there is to get some push behind this program. Otherwise, we will never get there.

Mr. KELLEY. Mr. Chairman, my information is that the industrial proposals represent nine different types of reactors, sir. The pressurized water—the Duquesne job—a direct boiling water reactor is being proposed by General Electric.

Senator JACKSON. That is the small plant out in the bay area?

Mr. KELLEY. Yes, sir, the west coast. It is a prototype or demonstration reactor. The sodium-graphite reactor is being proposed. There is also being proposed a fast breeder reactor. There is an organic moderated reactor being proposed. There is an aqueous homogenous reactor being proposed, and there are gas-cooled and sodium-cooled heavy water moderated reactors being proposed, and it was on this basis that I felt, and still feel, that if these reactors are completed we will have built the variety of designs that is desirable from a research and development point of view, and that therefore——

Senator JACKSON. In other words, you want to explore every possible approach and through the process of trial and error we come up with the best program in the end. That is just good sound science, isn't it?

Mr. KELLEY. That is good, sound science and it is my feeling that that is exactly what we are now doing under the industrial program, and that to superimpose on this a more or less arbitrary directive that we construct six others, would not add greatly to our technological knowledge and really advance the science.

Senator JACKSON. My understanding is at that point that Senator Gore's proposal would be to go beyond whatever the private companies are doing and get into areas that they are not in.

One of the problems now, Mr. Kelley, is that according to the testimony we have in the record to date, the Commission gets the proposal from the private company. They don't even suggest what type of reactor that should be. There is no overall coordination, and they have to accept what they propose.

At least that is the policy they are following. I don't think they have to, but they are doing it.

Mr. KELLEY. Actually, I believe the Commission staff has encouraged the submission of proposals for different types of reactors, rather than to have several construction proposals for the same type. They have certainly encouraged this in their various statements on the subject and in conversations with them.

As to whether 9 different types represent all of the best ones, I think perhaps Dr. Zinn could add something on this much more competently than I can, but we all know that there are almost innumerable combinations of things to create a reactor design, and after considerable review by some very competent people, it was decided that these 9 represent about the maximum number that should be pushed on a large scale at this time, until there is additional information on the performance of materials, on many other features of designs involved in some of those conceptions that are not represented here in the industrial program.

Senator JACKSON. Mr. Kelley, turning to page 5, I don't quite follow your reasoning in the second paragraph. You state that the Gore proposal will result in the waste of scientists, technicians, and engineers. I take it, then, that the logical conclusion of that is that if you expand this nuclear power effort, you are going to require more scientists which, therefore, will be wasteful.

Mr. KELLEY. No, sir. I certainly didn't mean to give that impression.

Senator JACKSON. What other conclusion could you come to?

Mr. KELLEY. May I amplify my statement a little bit, because as you realize, as president of a design firm, I must have rather strong convictions on this point or I would be here to encourage Senator Gore to create more business for me, but I sincerely believe that the present group of people competent in this field are now fully occupied, and that so long as they are engaged in a useful design and development program, they should stay on that until it is completed and we will train additional people as fast as we can.

Senator JACKSON. Are you saying that we should not expand our effort in this field because there is a limit on the number of scientists that are available?

Mr. KELLEY. That is not the end result of my feeling. My feeling is that as of today, we are woefully short of trained people.

Senator JACKSON. That, of course, is agreed by everyone. There is no dispute about that.

Mr. KELLEY. All right, sir. I would like to see the people now engaged in the industrial program stay on the industrial program.

Senator JACKSON. Would you want them to stay on the industrial program if there was something more vital to the national security coming up?

Mr. KELLEY. If this becomes a matter of national policy, I am a good soldier; I would fall in line with the rest. But at the moment I oppose the idea because I don't think it would add enough to our knowledge to warrant the diversion of the trained people at this time.

Senator JACKSON. Senator Gore.

Senator GORE. Mr. Kelley, I will make my exchange with you brief. The distinguished Senator from Oregon is here ready to testify.

I would like to point out to you, in response to the statement you have just made, that the DuPont Co. was the constructing contractor for the biggest single undertaking, the Savannah plant.

Mr. KELLEY. I am familiar with that, sir; yes, sir.

Senator GORE. The DuPont Co. has not submitted a proposal. The technology, the know-how, and the staff of the DuPont Co. is not being utilized in furthering the art of atomic power. Neither is the particular design used in the Savannah plant about which Dr. Zinn testified offers great promise, being exploited.

I only point this out to you as an illustration. On page 3 of your testimony you say:

> **The Geneva Conference on Peaceful Uses of Atomic Energy in August 1955 indicated that the United States has leadership in the development of nuclear technology. However, the question has been raised as to whether or not we are maintaining this leadership.**

I only ask you who has raised that question?

Mr. KELLEY. The implication, sir, as I read the bill, would indicate that it is because of this risk of losing a kind of leadership that we

should immediately embark on this program as a matter of national policy.

Senator GORE. The reason I ask you that question, Mr. Kelley, is that in the testimony yesterday, and in public statements, technology, industrial know-how and construction of atomic powerplants are all grouped together.

I have not raised any question about the leadership of the United States in technology in this field. The question I have raised—and I respectfully submit as a very valid question, and I believe it poses a vital issue before the country—is that we are losing the race for the development of industrial atomic power, not in technology.

However, there is the possibility that in losing the race for actual development of large-scale reactors, we may lose the lead in technology in the field, because as has been stated by the Atomic Energy Commission and all the authorities in the field, there is no substitute for experience. That is all I care to say for the moment.

Mr. KELLEY. Sir, it is my feeling that although we might lose leadership in the sense of the number of installed kilowatts of nuclear power, we would not lose our leadership in general technology.

Senator JACKSON. You made reference to the Shippingport reactor.

Mr. KELLEY. Yes, sir.

Senator JACKSON. Do you object to that pattern? You are familiar with the arrangements?

Mr. KELLEY. You mean the division of cost between the AEC and the power company?

Senator JACKSON. Under that proposal the Government is paying for and is directing the reactor construction, and private enterprise is building the facilities, the power-generating facilities, and so on, and will operate the reactor.

You made reference to it and the Government is in there pretty big, isn't it?

Mr. KELLEY. The Government is there in large part; there is no question of that. However, the other proposals for large power installations do not call for the same proportion of subsidy on the part of the Government and I personally prefer the one that has the Goverment in a reviewing position rather than as an active participant in the project.

Senator JACKSON. Of course, there are still a lot of ifs in this thing. As I understand, the companies want certain tax writeoffs, they want their insurance, they want relief from the Holding Company Act, and several other proposals that are contingent upon their going forward, isn't that correct, Mr. Kelley?

Mr. KELLEY. Yes, sir.

Senator JACKSON. Don't you think that in all fairness—I think we are all trying to work for the same objective—that private industry has a tremendous stake in this? We want private enterprise to participate to the maximum. We are not trying to put the Government in the nuclear power business.

We are trying to aid private enterprise. All of our great atomic energy installations have been operated by the biggest companies in America, Du Pont, General Electric, Union Carbide and A. T. & T., for example.

Well, they handle the telephone end of it, I guess, but outside of that, none of the big companies have been neglected. That is right, they do run Sandia; that is, a subsidiary of A. T. & T.—Western Electric.

I think that was a sound approach, because the great scientific reservoir of knowledge that is in private industry is the bulwark of technological progress in this country and we want to marshall all of that talent and know-how and use it to the maximum.

Don't you think that it would be good to get Government in here to point of needling private enterprise and to push them along is a good yardstick of progress?

Mr. KELLEY. Sir, you perhaps remember that I was also a part of the Manhattan project, so that I have had some experience at needling, but in this case I feel that the normal incentives of business will lead to the investment of private capital when it is technologically desirable to do so.

Senator JACKSON. That is the point, but now it is not economically feasible without a substantial Government subsidy, so you are not talking about straight private enterprise, because it requires a subsidy—I don't care what you call it—until the art has reached the point where we can produce economically feasible power; isn't that right?

Mr. KELLEY. Some of the proposals call for no open subsidy at this time, Mr. Chairman.

Senator JACKSON. Now wait a minute. Let's be honest about this. I don't think the Government can do it any cheaper. I don't think private enterprise can do it any cheaper. I think we are up against a cost situation.

You certainly wouldn't want to convey the impression that no subsidy is required direct or indirect in order to carry out the proposals submitted by the private companies, would you, Mr. Kelley?

Mr. KELLEY. I would still prefer, sir, that we let this development take its natural course, rather than to prod it with the construction of six additional powerplants with public funds.

You can't beat people over the head and tell them to produce inventions on a schedule, although pressure certainly helps in this.

Senator JACKSON. However, it is going to take a Government subsidy to get this program rolling; isn't that right?

Mr. KELLEY. I don't believe so, Mr. Chairman. I think the program is rolling now and that it will continue to roll with private money.

Senator JACKSON. There is a Government subsidy involved in the Shippingport operation, isn't there?

Mr. KELLEY. That one I grant.

Senator JACKSON. And you are suggesting that fast write-offs and a few other things, insurance subsidy, large subsidies, are really not subsidy at all?

Mr. KELLEY. Most of our industrial growth in this country, I remember, has been helped from time to time by the Government and I think perhaps the Government has helped enough.

Senator JACKSON. I just want to find out whether you are going to oppose private enterprise here. I think that the subsidization is a good thing. I am not against it. It is necessary, but let's be intellectually honest about it. Let's not try to tell the public that they are not going to be subsidized. That is my only point.

Mr. KELLEY. No comment.

Senator JACKSON. You have no comment? And you are representing the National Association of Manufacturers?

Mr. KELLEY. We could go on forever like this, Mr. Chairman, because it is my position that the Government is not required in this additional development right at this time, except for those things that have to do with radiation hazards. This subject is something that your committee has spent a great deal of time on.

Senator JACKSON. We don't want to take up a lot of time, but I think the record contradicts what you are saying if you are saying they don't need a subsidy. I think if they get you outside in the hall here, they may not be very happy with you, because we will have to read your testimony back when they want an amendment to the law.

I am not against this help. I want private enterprise to roll. But I always believe in trying to be honest with the American people on these things and not try to kid them along that this is not getting—I mean, that it is outside of the field of Government assistance.

I think progress under the Government or the progress that we made to date has played a very vital role in preserving private enterprise, and pushing it along. Otherwise, the private enterprise system itself could be destroyed. Some of us want to be sure that it is preserved and protected.

I think there is just an honest difference of opinion as to the means of achieving that objective.

Do you have any further questions?

Senator GORE. No.

Senator JACKSON. Thank you very much, Mr. Kelley.

Mr. KELLEY. Thank you, Mr. Chairman.

Senator JACKSON. Senator Morse?

Senator Morse, we welcome you this morning. We are very pleased to have your views on this subject.

STATEMENT OF HON. WAYNE MORSE, A UNITED STATES SENATOR FROM THE STATE OF OREGON

Senator MORSE. Mr. Chairman and Senator Gore, first I want to apologize for not being available at the beginning of the hearing this morning, but I was in a long-distance conference discussion. I thank the committee for permitting this delay and permitting me to testify at this time.

Mr. Chairman and Senator Gore, the people of the country have every right to hold Congress responsible for the delay in getting our atomic-power program started.

Now, nearly 2 years after the Atomic Energy Act of 1954 became law, the richest country in the world, the country which opened the way to atomic fission as a vast new energy resource, still appears unable to get its atomic-power program off the ground. That is my answer to Mr. Strauss' testimony of yesterday, Mr. Chairman. I don't know who Mr. Strauss thinks he is kidding, but he is not kidding those who know the facts, and one only has to look at the testimony already in this record and the material submitted to this record by such a reputable scientist as Dr. Zinn, to know that we are far behind in our atomic-energy program.

MONOPOLY OUTLOOK OF CORPORATIONS DELAYS ATOMIC-POWER PROGRESS

It is my conviction, after a study of the records and reports published by the Joint Committee on Atomic Energy, including the extensive hearings you have held, that it is the outlook of monopolistic private enterprise that is holding us back.

The huge industrial aggregations, whose control is extended throughout our private enterprise system through financial affiliations, subcontracts, and other interrelationships, have evinced little interest in advancing atomic power technology to the point where it will offer the people cheaper electricity.

Their proposed atomic power undertakings are designed merely to occupy the field so that there will be less force to the argument that the people, through the Federal Government, should proceed to develop their own atomic resource.

May I say, by way of deviation from my prepared statement, that there is somewhat analogous situation here with the rubber situation at the time of World War II. Had we waited for the rubber industry to do the job, the job wouldn't have been done, but the cooperation of the Government with the rubber industry produced the great synthetic-rubber program which was so instrumental in helping win the war, and we did the job through the Government and the industry.

The Senator from Oregon this morning is suggesting that we do this phase of the atomic-energy job through the Government and industry, and that we face up to the fact that if we are going to wait for industry to do it alone, the American people are going to pay a terrific economic price and they are going to run the danger of paying a disastrous security price.

Senator GORE. Mr. Chairman, may I ask a question?

Senator JACKSON. Certainly.

Senator GORE. Does the Senator not think it would be important, as it was important in the development of the synthetic rubber industry, for the Government itself because of the involvement of national interest to maintain the power of direction and emphasis as to what processes should be developed, rather than, as is the case with the present program, to give both the power of initiation and veto to the particular private concerns who may submit a proposal?

Senator MORSE. It is the position of the Senator from Oregon that the welfare of the people of this country demand that kind of protection from their Government. This Government has no right, in my judgment, to turn this program over to private enterprise at this point of its development.

From the standpoint of the security of the American people, I want to say that in my opinion the testimony of the witness that preceded me on this matter is just plain shocking and fails to recognize the primary obligation of this Government to protect the interests of the people in this whole nuclear development, because the development of nuclear power in this country in the last analysis is a great resource of this country and, like all great resources, belongs to the people. Each generation should function as a trustee of that resource for the benefit of future generations, and there is nothing incompatible with that statement and private enterprise, because private enterprise also

happens to be one of the trustees of the great resources so essential to promoting the general welfare of our people.

When I am testifying here this morning on this problem, I want to emphasize that I am talking about a matter that is of vital concern to the whole economic future of the American people. The Government has a great sacred trust in regard to the development of the program.

The Senator from Tennessee and the Senator from Washington know the fight that we put up in 1954 on this matter, and I will have something to say about it later on in this statement, but let me emphasize at the very introduction of my remarks, if we hadn't made that fight in 1954, if we hadn't stopped that steamroller on the floor of the Senate in 1954 when the plan was to get a vote the very afternoon that the atomic energy bill came to the floor of the Senate without an amendment added to it, the people would have lost a great heritage in this whole nuclear program, a program which in the last analysis belongs to them, so what we are talking about here this morning is but a continuation of that fight of 1954.

We didn't finish the job then, and the two Senators before me know why we didn't finish the job then. We warned that we hadn't quit fighting, and we have another great fight ahead of us now, and here it is. I am for meeting it head on and I am for meeting it by coming to the assistance of private enterprise and at the same time protecting the people's rights in this program, not turning this program over to the exploitation of private enterprise under the direct and indirect subsidies that they are proposing, about which I shall have something to say in a moment, and about which Senator Jackson has already cross-examined the previous witness.

The American people need to wake up to the fact that the greatest subsidies in America are the subsidies that are going to monopolies, and of course we also need to recognize that a monopoly is not a private enterprise.

I am always amused at these spokesmen for monopoly who like to speak about private enterprise as though they represent private enterprise, and of course they don't. They represent a form of economic totalitarianism, because in their little field of control that is what a monopoly is. It is an economic totalitarian instrumentality, and there is no competition in it, and nothing by way of private enterprise characterizing it.

To go back to my statement, these great corporations are chiefly responsible for the argument that the United States is so well endowed with conventional fuels that there is no rush about achieving economically feasible atomic power. And it is this kind of thinking that would put off by a quarter of a century the time when atomic power will be generally competitive with our power generated from conventional fuels.

The record shows that this take-it-easy attitude on the part of the corporations is not the only explanation for their failure to make the progress which they originally urged as the reason for turning the development of atomic power over to private enterprise.

PRIVATE COMPANIES CONDITION THEIR READINESS TO GO FORWARD

They are, in fact, openly insisting on certain concessions on the part of the Government as the price of going ahead. Two of these concessions are stated in the testimony of Walker L. Cisler, president of the Detroit Edison Co., Power Reactor Development Co., and Atomic Power Development Associates, Inc., as follows:

1. That neither the licensee corporation nor any member thereof or contributor thereto will become subject to the Public Utility Holding Company Act by reason of participation in this project.
2. That contributions of the members of the licensee corporation will qualify as deductible for Federal income tax purposes.

This is from the Joint Committee on Atomic Energy hearings February 7 to 23, 1956, page 248.

Is that a subsidy, gentlemen of the committee? Why, it is a clear handout. It is a recognition that these monopolies need this kind of a Government subsidy to do their phase of the job.

Subsequently, in the same testimony, Cisler said:

The progress of Power Reactor Development Co. has been retarded by the status of the company and its prospective members under both the Public Utility Holding Company Act and the income tax laws.

Further on in his testimony we learn that insurance is another hurdle which private enterprise feels must be surmounted before the corporations can move forward.

Previously, Willis Gale, chairman of the Commonwealth Edison Company of Chicago, had testified on behalf of the Nuclear Power Group, Inc., concerning their proposal to build "the largest all-nuclear powerplant yet scheduled." But he had stated:

Our proposal to the Commission and our contract with General Electric Co. are conditioned upon the satisfactory solution of the insurance problem, at a reasonable cost, before the end of 1957.

That is on page 239 of the hearings. In other words, he clearly indicates that he wants the Government to assume part of the burden of the insurance cost.

Gentlemen, it spells out the word "subsidy." I don't care what letters of the alphabet you use for the definition.

Gale made it perfectly clear that their idea was "for the catastrophe risk to be assumed by the Federal Government." He continued, on page 241:

The development of competitive nuclear power is in the interest of all the people. Why not have the risk shared by all the people through Federal Government?

I am testifying here this morning, Mr. Chairman and members of the committee, in behalf of a cooperative joint program between the people and private industry, whereby the people's rights in a nuclear program are going to be protected, too.

Now, Mr. Chairman, I have brought up the fact that private enterprise is asking these concessions, and others which I have not taken the time to enumerate, as the price of getting on with atomic power development, for several reasons.

In the first place, I suggest that in this field private enterprise is no longer behaving like the private enterprise that built America's great industrial power. Among other things, it is collectively working to

shove the risk off on the people, although it will ultimately insist before State and Federal commissions that it is entitled to returns on its common stock based on the theory that it represents risk capital.

But, in the second place, I want to call attention of the insistence of private enterprise that it get its freedom from regulation and its subsidies as a fundamenal indication that we cannot get the prompt development of atomic power which the country needs if we depend solely on private enterprise.

FAILURE TO ACCEPT SENATE AMENDMENT HOLDS BACK PROGRESS

Some of us made quite a fight in the Senate in 1954 for a new atomic energy law which would permit a dual development of this great new energy resource—a Federal program and a non-Federal program, supplementing and competing with each other.

I think those of us who made that fight can justifiably point to failure of the act to include provision for a federally owned and operated atomic power program as one cause of the present threat to United States leadership in this field.

You will recall that the Senate amended the original Cole-Hickenlooper bill to add a section 45, providing for such a Federal program, paralleling and supplementing non-Federal development under the licensing provisions.

A similar amendment was defeated in the House and the conferees agreed to elimination of section 45 of the Senate bill. But the conferees made certain compensating changes in other sections which the report of the House conferees contended would enable the Atomic Energy Commission itself, with congressional authorization, to construct large demonstration atomic powerplants.

I am here to support S. 2725, known as the Gore bill, because it would implement the language of the Atomic Energy Act of 1954 to authorize the Atomic Energy Commission to break the present logjam and get the country's atomic power program started.

Senator GORE. It would not only authorize, but of even more importance, direct.

Senator MORSE. Yes.

Senator GORE. Because it is plain that no matter what the authority is, unless there is direction, this program is not going to move.

Senator MORSE. I accept that addition to my statement and it is a very important one.

CONGRESS SHOULD ENACT GORE BILL AND AMEND 1954 ACT

But I would go further. For this committee, in calling these hearings, has expressed a desire for proposals for accelerating the civilian reactor program in this country. My recommendations, which I shall support in greater detail, are threefold:

1. Prompt enactment of S. 2725, which provides for Government construction of six large-scale demonstration atomic powerplants in addition to private construction presently contemplated.

2. Inclusion among these six regional Federal demonstration atomic powerplants of a 300,000 to 350,000 kilowatt capacity, multipurpose reconstruction of the Hanford, Wash., plutonium plant. The recently passed AEC authorization bill includes substantial funds for

modernization of the Hanford Works. It seems the height of improvidence to appropriate millions of dollars for modernization and improvement of this great plant without doing the full job of modernization to include power facilities.

A plant of this size could satisfy all of the power requirements of the Hanford Works, which presently drains off a substantial block of power from the Federal power system in the Columbia River Basin. Indeed, power facilities at Hanford could not only supply the Hanford Works but contribute about an equal amount to the system it now taps. I suggest that this is a reverse Dixon-Yates in which AEC power requirements would be met by atomic power.

Such additional power would be of special importance to the region because it would be firm, year-around power. As the chairman and other members know, there is the ever present threat in my region of seasonal power shortages when river flow is low. That threat will continue until upstream water storage is a reality at sites like Hells Canyon and Libby.

The advantage of developing power facilities at existing AEC installations is clear. They are going concerns with equipment and trained and cleared personnel. The establishment of new plants without using existing facilities first would mean wasteful duplication and loss of time.

3. Amendment of the Atomic Energy Act of 1954 to include a new section 45, substantially as originally passed by the Senate, providing the basis for a Federal atomic-power yardstick program. That yardstick would be not only for design, efficiency, and rates, but in addition, it would do what the public-power yardstick has done for conventional power—spur private companies into doing their public-service job.

A great deal has been said about the importance of accelerating this country's atomic-power program as a means to retaining our world leadership in this field of technological revolution. This seems to be a matter of great importance. Recent statements of the chairman of the joint committee, Senator Anderson of New Mexico, and other members of the committee, make it clear that this is very much in their minds. Furthermore, I expect it will be emphasized by other witnesses.

This cannot be stressed too much. Atomic energy for peaceful purposes may well decide whether the free way of life is to prevail over totalitarianism in the world.

IMPORTANCE OF FEDERAL PROGRAM TO DOMESTIC ECONOMY

Prompt development of atomic power is vital to the strength and progress of our domestic economy and the welfare of our homes, our farms, and the members of our tremendous army of industrial workers.

In terms of the great interest of all our people in abundance of low-cost electric power, we cannot afford to leave control of the development of atomic power to private enterprise which tells the people on every occasion that America is so well endowed with conventional fuels that it has no urgent need for progress in this field.

Actually, this sterile point of view does not reflect the kind of private enterprise which has built this country to its present preeminence. It reflects the monopolistic view which, as I have already said in my testimony, really is not private enterprise.

OUR OBJECTIVE IS CHEAPER ELECTRICITY

It would be a splendid thing for the country if Chairman Strauss of the Atomic Energy Commission would act on his better impulses, rather than his view that we are doing just fine as things are. In his address of November 9, 1955, before the Case Institute in Cleveland, Ohio, Mr. Strauss made this very important statement:

> We need atomic power, not to supplant the conventional sources of electricity, but to supplement them, and thus keep up with our steadily mounting demand for electrical energy which has been doubling about every 10 years. We cannot afford to delay until the crisis is upon us.
>
> The challenge is one not merely of finding the means of producing electrical power from atomic energy which will equal the cost of conventionally generated power. We must seek further to reduce those costs.
>
> If we could cut just one mill from today's average cost of producing a kilowatt-hour of electricity, it would mean a saving of about $450 million a year to the national economy. In 1965, it might mean a saving of $1 billion or more (p. 45, hearings, 1956).

According to the latest estimates of the tremendous upward thrust of our country's use of electricity, a 1-mill saving in today's average cost of producing a kilowatt-hour of electricity would mean a saving of $1.5 billion in the country's 1965 electric bill.

LOW-COST ELECTRICITY MEANS INDUSTRIES AND JOBS

Let me be very concrete about what this means in terms of industries and jobs, because the industries and jobs which low-cost can make available are very important to the region which I represent.

The February 28, 1956, issue of the Wall Street Journal contained a full-page advertisement of the General Electric Co. entitled "As General Electric Sees It." Among other evidences of the future of electricity, the ad shows the picture of a modern industrial worker operating the control board of some complicated machine. Under this picture is the inscription:

> Electricity will work harder in industry. By 1965, the average manufacturing worker can have at his command electricity equal to the energy of 500 strong men—34,000 kilowatt-hours a year. By extending the productive arm of working men and women, electric power makes possible jobs requiring skill and judgment—creates new industries, more employment opportunities.

Now, the possible 1-mill saving in the cost of electricity which Chairman Strauss is talking about would, by 1965, mean a saving of $34 per year for every man and woman on the country's industrial production line.

And in terms of future prospects of residential and rural use of electricity, that little 1-mill per kilowatt-hour would mean savings of $20 to $30 a year in the electric bills of our households and farms.

I point this out because there is good substantial evidence to counteract all the pessimistic talk which has become fashionable to dull the people's expectancy of the early arrival of feasible atomic power. In other words, 1- and even 2-mill savings in the cost of producing

a kilowatt-hour of electricity are possibilities of the very near future in many regions if we undertake a vigorous Federal program of atomic-power development.

Let there be no misunderstanding about what I am saying. I am not urging an all-Federal program. But I am urging an all-out Federal program—with the certainty that if construction of large Federal atomic powerplants is launched the private power companies will quickly discover that they, too, can build economical atomic powerplants. The private power companies will also discover that they can do this without concessions in the way of statutory exemption from Federal regulation or subsidies which, in fact, would transfer all the risk to the taxpayers.

COMPANIES WANT PEOPLE TO ASSUME THE RISKS

Mr. Chairman, you will recall the statement I quoted from Commonwealth Edison's Chairman Gale when he was urging Federal assumption of responsibility for catastrophe insurance. To quote him again, he told this committee in February:

> **The development of competitive nuclear power is in the interest of all the people. Why not have the risk shared by all the people through the Federal Government?**

The fact is, of course, that to date the people through the Federal Government have assumed all of the risk for the development of this new energy resource. Everything indicates that further progress toward prompt development of low-cost atomic power will depend on the people continuing to take the major risk.

There seems no sound reason why they should not take this risk directly through Federal construction of a number of large demonstration atomic powerplants and get the prompt development they are entitled to.

Spokesmen for the Atomic Energy Commission have frankly stated that solution of the remaining problems in the development of low-cost atomic power requires the construction of a number of large plants.

What this means is that the necessary funds must be available to back orders which will put the wide range of chemical, metallurgical, and equipment companies, ready to experiment in this field, to work. So far the firm orders have not been forthcoming from the private power company consortiums. They are held up until all the company conditions are met.

Federal acts amended to exempt the participants from the Holding Company Act, Federal provision for catastrophe insurance, Atomic Energy Commission agreement on other forms of Federal subsidy, deductibility of expenditures for Federal tax purposes, et cetera.

The quickest way to clear all these obstacles which are holding back progress is for Congress to authorize the Atomic Energy Commission to go ahead. Already the people have put $14 billion into all phases of atomic development. Provision for six Federal atomic powerplants with a combined capacity of 1,500,000 kilowatts, located in regions which need low-cost power, would involve the investment of possibly less than half a billion dollars more, largely reimbursable to the Government through sale of the 12 billion kilowatt-hours per year which the plants would produce.

PEOPLE HAVE RIGHT TO EARLY LOW-COST ATOMIC POWER

Now, what have the people of the country to expect from such a program? I have already given a partial answer in connection with my proposal for a study by the Atomic Energy Commission leading to quick construction of large atomic power facilities at the Commission's existing Hanford, Wash., plant.

I called attention to the progress report of Francis K. McCune, vice president and general manager of General Electric Co.'s atomic products division, dated May 24, 1954, in which he said:

> * * * privately financed atomic plants will compete successfully with conventional powerplants in 5 to 10 years.

That means perhaps as early as 1959 and not later than 1964.

I cited McCune's comparative power costs for the 300,000 kilowatt boiling water thermonuclear station on which he based his conclusions, and a station of the same capacity using conventional fuel. The figures, based in both instances on private fixed charges, are:

	Mills per kilowatt-hour	
	Boiling water reactor	Coal plant
Fixed charges	4.65	3.00
Operating cost	.70	.50
Fuel cost	1.35	3.40
Total	6.70	6.90

I noted that in 1954, Dr. Lawrence R. Hafstad, then director of the Atomic Energy Commission's Division of Reactor Development, speaking before the atomic industrial forum, urged private power companies to get moving on nuclear power, indicating that within 10 years economically priced atomic electric energy could be created.

I also noted the April 1955 statement of Hafstad's successor, Kenneth Davis, addressing the same group, that a nuclear power station built in 10 to 15 years will be as good as the best steam plant constructed today—or at per installed kilowatt costs ranging between $125 and $140. And Davis predicted that costs would go down even further.

LATEST GENERAL ELECTRIC CO. FIGURES JUSTIFY OPTIMISM

I further call attention to an article in the June 13, 1955 issue of the Electrical World written by three General Electric Co. engineers, describing a dual-cycle, 180,000 kilowatt reactor powerplant.

The authors showed that the investment per installed kilowatt could be reduced to $200 by 1960 and $190 by 1965. They produced a chart which forecast that the power cost of a 180,000 kilowatt conventional steam plant, with an investment of $150 per installed kilowatt and the dual-purpose reactor powerplant at $200 per installed kilowatt would be practically identical, at slightly over 6 mills per kilowatt-hour.

I had the data contained in the GE engineer article in the June 13, 1955, Electrical World adjusted to reflect the power cost for such a

plant, if constructed by the Federal Government at Hanford, with low interest rate Federal financing. The adjusted figures showed:

Item		Cost
Investment per installed kilowatt		$200.00
Fixed charges per year		10.60
Fixed charges per kilowatt-hour	mills	1.52
Fuel cost per kilowatt-hour	do	1.60
Operation and maintenance per kilowatt-hour	do	.80
Total cost per kilowatt-hour	do	3.92

RECENT SYNTHETIC PESSIMISM IS COMPANY STRATEGY

Now, it will be suggested that more recent estimates by Reactor Division Director Davis have been less optimistic and that elaborate figures were prepared for the McKinney panel in what was known as the Prentice report, projecting economically feasible atomic power further into the future, at least in all but the high-fuel-cost areas. Much also will be said about what appear to be newly discovered fuel elements and other technical problems.

But a careful study of all the shifting statements suggests that they result from a studied attempt to chill the expectations of the people until all the conditions have been adjusted to suit the private monopolistic interests which are at present calling the tune.

The new pessimism, in fact, may be treated as a byproduct of the unreadiness of private interests to put up the money necessary to lick the technical problems rather than the cause of the private reluctance about going ahead to win the atomic power race.

THE ANSWER TO SYNTHETIC PESSIMISM IS ENACTMENT OF GORE BILL

The answer to this new pessimism, of course, is to enact S. 2725, the Gore bill, and get started with six or more large demonstration powerplants in the various regions into which the country is divided.

I have expressed skepticism as to the bona fide nature of this new pessimism about the possible rapidity of progress. To back me up I have the statement of AEC Chairman Strauss, as reported by the November 11, 1955, Wall Street Journal, to the effect that there is "justification" in believing that the United States will obtain economical electric energy from the atom "possibly sooner than even the most optimistic of prognosticators believe." And we also have Chairman Strauss stating the opinion that the more recent forecast of Reactor Development Division Davis is too conservative.

Furthermore, I have the very able supplemental statement with appendixes, submitted by Walter P. Reuther, vice president of the AFL-CIO, as member of the Panel on the Impact of the Peaceful Uses of Atomic Energy, which made its report to the Joint Committee in January 1956. Mr. Reuther's analysis exposes the studied attempt of those preparing the nuclear power figures for the panel to support an overpessimistic forecast of the future of atomic power in this country.

OAK RIDGE SCIENTIST PREDICTS ZERO FUEL COSTS—4-MILL POWER

I shall refer briefly to the panel's conclusions on this subject. But first I want to note the fact that Reuther has emphasized the importance of a report on The Technology and Economics of Nuclear

Power, prepared for the panel by Robert A. Charpie of the Oak Ridge National Laboratory.

Charpie, commenting on the principal power report—the Prentice Report—estimates that operation and maintenance costs for nuclear power plants will be 50 percent higher than for conventional steam plants, says:

> There is no reason why reactor stations should have any higher operating costs after we have obtained some experience with them than do thermal stations.

Charpie says further, speaking of privately financed nuclear powerplants:

> The problem of 4-mill power reduced to one of constructing homogeneous breeders at a capital cost of approximately $200 per kilowatt, or fast breeders for approximately $225 to $250 per kilowatt.

Charpie looks forward to lower fuel costs than the Prentice Report, which figures them at 3.0 to 3.8 mills per kilowatt-hour in 1960, 1.6 to 3.0 mills in 1965, and 1.0 to 1.5 mills by 1980. Charpie says:

> Nuclear reactor stations are more like a hydroelectric station in the long run in that they will produce eventually zero-cost fuel. It is clear that if the reactor is a breeder which breeds by a sufficiently large margin, the value of the additional fuel produced will offset the chemical recycling costs. Thus the net fuel cost is zero.

WHAT ZERO FUEL COSTS OFFER THE PEOPLE

Now, let me pause for a word as to what this zero fuel cost would mean in terms of possible overall atomic power costs. Modifying the Prentice Report estimates for future atomic power costs simply to the extent of substituting zero fuel costs, we get the following costs for privately and publicly financed atomic powerplants, operated at 85-percent load factor:

Mills per kilowatt-hour	Privately financed	Publicly financed
1960	4.3–5.0	2.9–3.3
1965	4.1–4.7	2.7–3.1
1970	3.8–4.3	2.5–2.8
1975	3.3–3.7	2.2–2.5
1980	3.1–3.5	2.1–2.3

These figures assume nuclear powerplant costs ranging from $200 to $240 in 1960 and coming down to ranges of $194 to $228 in 1965, $176 to $205 in 1970, $155 to $180 in 1975, and $144 to $165 in 1980.

An increase of 25 percent in such cost estimates to meet the possible requirements of breeder reactors would increase the per-kilowatt-hour figures for private financing by a maximum of just over 1 mill in 1960, scaling down to three-quarters of a mill in 1980. The corresponding increase for public financing would scale down from about six-tenths of a mill per kilowatt-hour in 1960 to four-tenths of a mill in 1980.

In other words, the people can look forward in the near future to atomic power at costs about as low as those from good hydroelectric developments, if the Federal Government breaks the sit-down strike of the private power companies by enacting S. 2725, the Gore bill, and investing something like a half a billion dollars which the Govern-

ment will earn back in power revenues in large demonstration atomic powerplants.

THE RECENT M'KINNEY PANEL PROMISES EQUALIZATION OF POWER COSTS AT LOW LEVELS

The report of the McKinney Panel—the Panel on the Impact of Peaceful Uses of Atomic Energy—brings out a very important aspect of the possibilities I have just pictured.

On page 47 of the panel report, under the caption "General Impact Considerations," the panel expresses the judgment that nuclear fuels:

> (1) will almost certainly compete and very possibly make possible lower power costs than conventional fuels in present high-cost power areas; and (2) will probably at least compete with conventional fuels for power generation in all areas except those in which fuel transportation costs are negligible.

The panel then states:

> The trend that results from such a generalized forecast is toward the equalization of power costs at lower levels in all areas (p. 48).

Mr. Chairman and members of the committee, in terms of the balanced development of all the country's regions; in terms of the rural electric cooperatives, and the farms that they serve; in terms of municipal electric systems, public power districts and industries, this fact is of enormous importance.

PROMPT DEVELOPMENT WILL MAKE GREAT CONTRIBUTION TO NORTHWEST

Mr. Chairman, great atomic powerplants working together with the great hydroelectric plants already built and to be built in the Federal Columbia River Basin program will make a tremendous contribution to the continued building of a prosperous economy serving prosperous farmers and wage earners and business institutions in the Pacific Northwest.

I am convinced that the country cannot afford to wait for private enterprise to satisfy all its vested interests in the status quo if we are to have economical atomic power promptly. It is clear that they will not move ahead until they have secured a wide range of concessions to protect their monopoly positions, concessions such as unlimited patent rights, private ownership of special nuclear material, full opportunity to create great nuclear fuel trusts, and to sell nuclear fuel on an unregulated market, Federal assumption of the major insurance risk, freedom from Holding Company Act regulation, et cetera, et cetera, ad infinitum.

The country can't wait, nor can it afford the concessions demanded by the companies, if the people are to get the full benefits of their vast new energy resource.

IMPORTANCE OF SMALL BUSINESS PARTICIPATION

Mr. Chairman, there is one other important consideration which emphasizes the importance of initiating immediately a large-scale Federal demonstration atomic power program. I refer to the fact that it will make possible encouragement of widespread participation by smaller corporations capable of making an imaginative contribution

to solution of the technological problems which we face in moving to the lowest possible cost atomic power.

I think this is important because it will bring real private enterprise into the field as contrasted with the few big corporations which have so far enjoyed a ringside seat in the development of the atomic age.

Much experience in the electrical field has indicated that the inventions come from the smaller independent companies, only to be bought up subsequently by great corporations who enjoy a sort of vicarious credit for technological progress.

If we are going to get costs down, let's have Federal funds to encourage the smaller corporations to get started with the inventions. A cursory glance at recent issues of McGraw Hill's monthly publication Nucleonics suggests that American equipment manufacturers are ready to go as soon as funds back up orders for experimental or demonstration atomic powerplants, ranging all the way from 5,000 to 500,000 kilowatts of electrical capacity.

CONCLUSIONS SUPPORT PROMPT UNDERTAKING OF FEDERAL PROGRAM

Mr. Chairman, as I hope my statement has made clear, the position which I am taking in support of prompt enactment of S. 2725, the Gore bill, followed by amendment of the Atomic Energy Act of 1954 to provide authorization for a Federal atomic power development program, is based on my conclusions from a wide range of evidence. I may summarize those conclusions as follows:

1. The people of the United States are continuing to pour hundreds of millions of dollars a year into the peacetime uses of atomic energy on top of the $14 billion they have already invested in all aspects of the atomic program. Private enterprise, which promised much to get the 1954 act, continues to go slow and insist that the people assume the risks. Under these circumstances, there is no reason why the people should not control the rate of development and secure the full advantages of the low-cost power which this new energy resource can shortly make available.

2. The whole attitude of those guiding our civilian atomic program is passive, rather than active, negative rather than positive, so far as the public interest in low-cost power is concerned. This country, unless it has lost its pioneering spirit, should be talking in terms of using this new resource to bring power costs down, rather than speculating on its use at some later time, when conventional fuels fail to meet the demand. We should be rejoicing in the fact that within 10 years, when the country's power requirements have more than doubled, the new energy resource offers possible savings of a billion and a half dollars a year in the country's electric bill for each one-mill cut in the cost of producing energy.

Our whole attitude of complacency, engendered by our presently abundant conventional energy resources, threatens our world leadership in the field of peacetime atomic development. Every week brings new information of the active competition of Russia and Great Britain for such leadership, which will ultimately involve commercial leadership in a highly competitive world. To meet this international competition will require the rapid undertaking of large-scale atomic power

projects, backed by far greater funds than privately owned corporations have shown themselves ready to commit.

4. Rapid progress in our atomic power program requires large Federal funds behind orders which will stimulate invention and discovery on the part of hundreds of small business enterprises. Except under subcontracts from the favored few big equipment, chemical and metallurgical companies, these smaller corporations have not been afforded an opportunity to show what truly free enterprise can do in the way of quick solution of remaining problems affecting the possibility of very low-cost atomic power.

5. Our whole procedure to date has missed the opportunity, such as the AEC Hanford works offer, to broaden into a full-scale multipurpose undertaking for the production of power required for the works itself, as well as to meet the expanding power requirements of the region.

6. The prompt undertaking of a Federal program of large-scale demonstration atomic powerplants offers the people in all parts of the country the splendid prospect of power costs at the lowest possible levels, hitherto available only in regions endowed with unlimited hydro, coal, or petroleum resources. This means the possibility of low rates and expanding consumption for homes, farms, and industries everywhere.

Mr. Chairman and members of the committee, on the basis of these conclusions, I am convinced that a few billion dollars invested over the next 5 years in a crash Federal atomic power program would pay off a hundred times over in terms of (1) the continued confidence of the peoples of the world in the technological and scientific leadership of our great democracy; (2) the strength of our economy and its ability to support ever higher living standards in a highly competitive world; and (3) the maintenance of our industrial lines of defense in case of war, which might well be broken by disruption of our rail transportation system if the country's electric power potential remained largely dependent on coal and oil.

In comparison with the tens of billions we are appropriating each year to maintain our war potential, the commitment of a few billions to the achievement of low-cost atomic power seems a small insurance premium to provide full protection for these vastly important factors in our domestic and international affairs.

For this reason, Mr. Chairman, I urge prompt approval by Congress of S. 2725, an amendment of the Atomic Energy Act of 1954, to provide the basis for full speed ahead with a Federal program supplementing and stimulating any program which private enterprise may undertake under Federal license.

I am convinced that such action will provide the greatest possible stimulus to true private enterprise in this field and in our entire economy. Such action will also provide assurance that free and neutral nations will not be forced to turn to Russia in order to participate fully in the atomic age.

I want to thank the committee, and I shall be glad to take your questions.

Senator JACKSON. Thank you, Senator Morse. We appreciate having your detailed comments on Senator Gore's bill.

Senator Gore?

Senator GORE. I congratulate Senator Morse on a very able presentation and detailed analysis of the problem that faces us. I would like very much to ask some questions, but in view of the list of witnesses who are expected to testify this morning, I will engage him on the floor of the Senate some day.

Senator MORSE. I think shoulder to shoulder.

Senator JACKSON. Senator Bricker?

Senator BRICKER. No, thank you.

Senator JACKSON. Thank you very much, Senator Morse.

The next witness is Mr. Elmer L. Lindseth, representing the Edison Electric Institute.

Is Mr. William Clapp here?

STATEMENT OF WILLIAM J. CLAPP, REPRESENTING FLORIDA NUCLEAR POWER GROUP

Mr. CLAPP. Yes, sir.

Senator JACKSON. Mr. Clapp, I understand that you would like to have your statement included in the record.

Mr. CLAPP. I would, please, sir.

Senator JACKSON. At this point? Would that be all right?

Mr. CLAPP. Either that or following this testimony.

Senator JACKSON. Or following Mr. Lindseth's testimony?

Mr. CLAPP. Yes, sir.

Senator JACKSON. I have just read your statement. It is a very fine statement. I just finished reading it. You are speaking in behalf of the Florida Nuclear Power Group, of which the Florida Power Corp. is a member. You are the president of the Florida Power Corp.; is that right?

Mr. CLAPP. That is correct.

Senator JACKSON. And you are also representing the Florida Power & Light Co. and the Tampa Electric Co. in connection with your statement?

Mr. CLAPP. Our Florida Nuclear Power Group.

Senator JACKSON. Yes. If there is no objection, then, Mr. Clapp's statement will follow the statement by Mr. Lindseth.

Do you have any additional comments you wish to make?

Mr. CLAPP. No; except to assure you, sir, we do appreciate the opportunity of leaving this information with you and telling you that it is our sincere effort and desire to get started on our program down there.

Senator JACKSON. I note that you expect to have a large-scale high-temperature reactor to go into operation serving all three systems by 1962.

Mr. CLAPP. Yes, sir; that is our aim.

Senator JACKSON. Assuming you complete your design and development work by 1958.

Mr. CLAPP. Yes.

Senator JACKSON. I also have a statement by Mr. Harold Quinton, the president of the Southern California Edison Co. Is Mr. Quinton present?

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STATEMENT OF ELMER L. LINDSETH, THE EDISON ELECTRIC INSTITUTE

Mr. LINDSETH. No, Senator; he is not, but on his behalf, I would ask leave to insert that in the record following my presentation.

Senator JACKSON. His statement, then, will follow that of Mr. Clapp's, if there is no objection, which will, in turn, follow yours.

Mr. LINDSETH. Thank you.

Senator JACKSON. Mr. Lindseth, you may proceed.

Mr. LINDSETH. My name is Elmer L. Lindseth. I am president of the Cleveland Electric Illuminating Co., a member of the Edison Electric Institute, committee on atomic power, and a past president of the institute.

On behalf of the institute, our committee has appeared before the joint committee on two previous occasions this year. I wish to express the appreciation of our member companies for the opportunity you have granted us to appear here today.

This statement has been authorized by our institute's committee on atomic power, which comprises 14 member company executives. The names and business affiliations of the members of the committee are appended to this statement.

The member companies of the Edison Electric Institute serve 93 percent of the customers receiving electric service from the investor-owned utility industry which, in turn, serves 80 percent of all the electric customers in the United States. Thus, in effect, the institute represents the great bulk of that 80 percent of our country's electric customers, and it is for that group of customers and for the 186 companies serving them that I am testifying here today.

S. 2725 would authorize and direct the Atomic Energy Commission to construct six nuclear power reactors, to demonstrate—

> * * * the practical value of utilization facilities for industrial or commercial purposes pursuant to section 31 of the Atomic Energy Act of 1954.

The member companies of the Edison Electric Institute are unalterably opposed to this bill in particular and to legislation of this general type.

We believe that this bill and the arguments advanced in support of it are unsound for several basic reasons. First, the investor-owned utility companies have been making and are continuing to make distinct and adequate progress in the development of nuclear power.

Secondly, the projects which industry already is undertaking will demonstrate the practical value of power reactors for industrial or commercial purposes, which is the stated purpose of S. 2725.

Thirdly, we believe that the United States can maintain world leadership in this important field through continued emphasis on quality and without resort to a "crash" quantity program.

Fourthly, by reason of the preference clause in section 44 of the Atomic Energy Act of 1954, S. 2725 would discriminate against the great majority of America's electric customers receiving service from investor-owned utilities.

Finally, contrary to testimony of others before the Joint Committee earlier this year, the building and operation of demonstration reactors by the Government would not in any sense serve as a fair "yardstick" by which to measure atomic power costs.

The institute has made detailed forecasts of future growth in the demand for power in the United States and has concluded that we may reasonably expect increases averaging 7 percent compounded annually in the foreseeable future. This means that domestic generating capacity must be doubled in the next 10 years and quadrupled in the next 20 years.

The long-range expansion programs of the utility companies contemplate growth of these proportions, subject to revision upward or downward as may be indicated by regular reviews of our forecasts. I wish to emphasize that our first objective in looking ahead is to be prepared to meet in full and on time the power needs of our customers and our country, as we have in the past.

Our member companies have spent, and are continuing to spend, millions of dollars to develop economic nuclear power. Our committee has pointed this out in testimony before this committee earlier this year, and we reiterate it here. A total of 44 investor-owned companies are singly or in groups participating in the planning and building of nuclear powerplants.

More than 300 million private enterprise dollars are involved in the planning, construction, and attendant research for these plants which together will have an ultimate capacity in excess of 1,100,000 kilowatts.

On March 22, 1955, Consolidated Edison Co. applied for a license to build a reactor. No Government help was asked and there were no conditions to the proposal. A construction permit enabling the company to proceed was granted on May 4, 1956, some 13 months after the application was made.

The Commonwealth Edison Co. also obtained its construction permit on May 4. This time interval serves to illustrate the tremendously difficult job which AEC has in considering the appropriate safety standards and other complex facets of each reactor undertaking before construction permits and then licenses are granted.

Officials of individual utilities and equipment manufacturers actively engaged in specific projects are testifying at these hearings regarding dollars actually spent and progress attained. When consideration is given to their testimony, we believe it will be abundantly clear that there is substantial progress.

I come now to the allegation that there is a need for the Government to demonstrate the practical value of power reactors for industrial or commercial purposes. No new program at the taxpayers' expense is needed to accomplish this goal.

In the original AEC 5-year power reactor development program, five reactor concepts were chosen as being technically feasible and potentially capable of producing economically competitive nuclear power. Private groups have announced their intent to build large-scale plants embodying four of these designs and actions toward this objective are proceeding in an orderly manner. The fifth concept is the basis for a large-scale construction project by a public power district.

Reactors for 3 of these 5 concepts—pressurized water, fast breeder, and sodium graphite—are to be built under the AEC's power demonstration reactor program. The purpose of this program, as stated in the AEC news release of January 10, 1955, is "to demonstrate the practical value of such facilities for industrial or commercial

purposes." This purpose is identical to the stated purpose of S. 2725.

The other two reactor concepts in the original AEC 5-year program—boiling water and homogeneous—are to be built by private industry for the same purpose, but are not under the power demonstration reactor program because no financial assistance is being asked of the Government.

These are the projects proposed by the Commonwealth Edison Co. and Pennsylvania Power & Light Co., respectively. Other projects or proposals on a no-assistance basis are the pressurized-water thorium-converter reactor of Consolidated Edison Co., the large-scale reactor proposed by three Florida utility companies of a type not yet selected, and the small-sized boiling water reactor plant to be built by General Electric Co. and Pacific Gas & Electric Co. for which a construction permit was issued on May 15. The total private investment in these five reactors would be an estimated $191 million.

Since AEC's original 5-year program was established, two new and promising reactor designs have been added. AEC has announced that it has signed a contract with North American Aviation, Inc., for the building of one of these, a small-scale organic moderated reactor experiment, and that it is negotiating with Babcock & Wilcox for a similar undertaking for the other, the liquid metal fueled reactor.

As these and other promising designs or variations are more fully developed, it is expected that industry will again be ready to take major responsibility for their commercial development with private capital. Past experience clearly supports this expectation.

In announcing the second round of the power demonstration reactor program on September 21, 1955, AEC reiterated the purpose of the program as—

> to demonstrate the practical value of such facilities for industrial or commercial purposes.

In this case, small reactors were specified and, because of this the responses came largely from cooperatives and municipal systems.

In addition to the reactors which will be constructed under the civilian applications program, the United States has had and is projecting a very comprehensive program of military, propulsion, production, testing, and research reactors located throughout the country. Progress made in the engineering, construction, and operation of these many different types of reactors has already been and will continue to be of great help in our efforts to overcome technological roadblocks in the civilian power reactor field.

Published sources indicate a total of 89 different reactors that have been completed or are under development, planned, or applied for in the United States. A tabulation of these 89 reactors is appended hereto. We note that, based on public information and statements, this total of 89 reactors is substantially in excess of the number of reactors completed, under development, or planned by all the other countries of the world taken together. A tabulation showing this worldwide comparison also is appended to this statement.

I would like to direct the attention of the committee to the table appended, marked No. 3. This table shows the status of reactor development as to numbers and types throughout the world to the extent such information is available from published sources. Types are

listed basically according to moderators. Note that the aggregate of all reported reactors worldwide is less than the total for the United States alone; that is, among the 12 nations of the world who today have reported reactors in being or planned, the total number is 63, including 17 for Russia. Of these, 10 are undisclosed as to type other than that they are a part of the U. S. S. R. 5-year program.

Note that the total for the United States is 89, which exceeds the number elsewhere in the entire world.

In addition, in order to show the broad interest which investor-owned utility companies in the United States have in the nuclear power program, we have appended tabulations of the nuclear power-plants in which utility companies are participating and of the 106 utilities having AEC access permits, according to AEC releases.

(The information referred to follows:)

EEI COMMITTEE ON ATOMIC POWER

W. L. Cisler, president, the Detroit Edison Co., Detroit, Mich.
P. A. Fleger, chairman, Duquesne Light Co., Pittsburgh, Pa.
G. M. Gadsby, chairman, Utah Power & Light Co., Salt Lake City, Utah.
A. S. King, president, Northern States Power Co., Minneapolis, Minn.
E. L. Lindseth, president, the Cleveland Electric Illuminating Co., Cleveland, Ohio.
J. W. McAfee, president, Union Electric Co. of Missouri, St. Louis, Mo.
C. B. McManus, president, the Southern Co., Atlanta, Ga.
I. L. Moore, president, New England Electric System, Boston, Mass.
C. E. Oakes, president, Pennsylvania Power & Light Co., Allentown, Pa.
R. G. Rincliffe, president, Philadelphia Electric Co., Philadelphia, Pa.
H. R. Searing, chairman, Consolidated Edison Co. of New York, Inc., New York, N. Y.
Philip Sporn, president, American Gas & Electric Co., New York, N. Y.
N. R. Sutherland, president, Pacific Gas & Electric Co., San Francisco, Calif.
Chairman: E. H. Dixon, president, Middle South Utilities, Inc., New York, N. Y.

Nuclear reactors in the United States—Completed, under development, planned, or applied for

PRESSURIZED WATER REACTORS, WATER COOLED AND MODERATED

Name	Owned by—	Location	Function	Date of operation
Low-intensity reactor MTR mockup.	Atomic Energy Commission.	Oak Ridge, Tenn.	Research	1950
Materials testing reactor	do	Arco, Idaho	Testing	1952
Submarine thermal reactor:				
Mark I	Navy	do	Submarine	1953
Mark II	do	Nautilus	do	1955
Shippingport	AEC-Duquesne	Shippingport, Pa.	Power	1957
Westinghouse test reactor	Westinghouse	Blairsville, Pa.	Testing	1957
Engineering test reactor	Atomic Energy Commission.	Arco, Idaho	do	1957
Army package power reactor	do	Fort Belvoir, Va.	Power	1957
University of Florida reactor	University of Florida.	Gainesville vicinity	Research	1959
Yankee Atomic Electric Co.	Yankee Atomic Electric Co.	Rowe, Mass.	Power	1960
Consolidated Edison Co.	Consolidated Edison Co.	Indian Point, N. Y.	do	1960
Submarine fleet reactor	Navy	Not stated	Submarine	(1)
Large-ship reactor	Atomic Energy Commission.	Arco, Idaho	Large ship	(1)
Submarine advanced reactor	do	West Milton, N. Y.	Submarine	(1)

[1] Not stated.

BOILING WATER REACTORS, WATER MODERATED AND COOLED

Name	Owned by—	Location	Function	Date of operation
Boiling experimental reactor:	AEC-ANL	Arco, Idaho	Experimental	1953
Borax I (destroyed)				
Borax II (rebuilt as Borax III).	do	do	do	1954
Borax III	do	do	Power prototype	1955
Experimental boiling water reactor.	do	Lamont, Ill	do	1956
General Electric	General Electric	Livermore-Pleasanton, Calif.	Research-power	1957
Nuclear power group (dual cycle).	Commonwealth Edison.	Morton, Ill	Power	1960
Elk River	Elk River Rural Electric Co-op Association.	Elk River, Minn	do	1960

SWIMMING POOL REACTORS, WATER MODERATED AND COOLED

Bulk shielding reactor	AEC-ORNL	Oak Ridge, Tenn	Research	1950
Convair research reactor	Not stated	Fort Worth, Tex	do	1953
Tower shielding reactor	AEC-ORNL	Oak Ridge, Tenn	do	(1)
Pennsylvania State University.	Penn State University.	University Park, Pa	do	1955
University of Michigan	University of Michigan.	Ann Arbor, Mich	do	1956
Naval Research Laboratories	Naval Research Laboratory.	Washington, D. C	do	1956
American Machine & Foundry.	A. M. & F	New York City area	do	1956
Battelle Memorial Institute	BMI	Columbus, Ohio	do	1956
Livermore Laboratory (low-power test reactor).	AEC	Livermore, Calif	do	1957
Oak Ridge research reactor	do	Oak Ridge, Tenn	do	1957
Omega West	do	Los Alamos, N. Mex.	do	(1)
Watertown Arsenal	Watertown Arsenal	Watertown, Mass	do	(1)
Washington State	Washington State	Pullman, Wash	do	(1)

HOMOGENEOUS REACTORS

Low-power water boiler	AEC	Los Alamos, N. Mex.	Research	1944
High-power water boiler	do	do	do	1944
Super-power water boiler	do	do	do	1951
Homogeneous reactor experiment (dismantled).	do	Oak Ridge, Tenn	do	1952
Homogeneous test reactor 1 (dismantled).	do	do	Power prototype	1952
North Carolina State reactor.	North Carolina State College.	Raleigh, N. C	Research	1953
Los Alamos power reactor 1	AEC	Los Alamos, N, Mex.	Power prototype	1956
Los Alamos power reactor 2	do	do	do	1956
Homogeneous test reactor 2	do	Oak Ridge, Tenn	do	1956
Armour Research Foundation.	Armour Research Foundation.	Chicago, Ill	Research	1956
Gamma Corp	Gamma	Mansfield, Mass	do	1956
UCLA Medical	UCLA	UCLA Medical Center.	Research and treatment.	1956
Wolverine	Wolverine Electric Co-op.	Vicinity Hersey, Mich.	Power	1959
Pennsylvania advanced reactor.	Penn Power & Light Co.	Pennsylvania	do	1962
North American Aviation	Not stated	Downey, Calif	Research	(1)

HEAVY WATER REACTORS

Chicago pile 3	AEC	Chicago, Ill	Research	1944
Modified to Chicago pile 3'.	do	do	do	1950
Chicago pile 5	do	Lamont, Ill	do	1953
Massachusetts Institute of Technology.	MIT	Cambridge, Mass	Research-medical therapy.	1957-59
Chugach	Chugach Electric Association.	Vicinity Anchorage, Alaska.	Power	1961
Savannah River (5 reactors)	AEC	Aiken, S. C	Production	(1)
Brookhaven Medical	do	Upton, N. Y	Research	(1)

[1] Not stated.

GRAPHITE REACTORS

Name	Owned by—	Location	Function	Date of operation
Chicago pile 1	AEC	Chicago, Ill	1st reactor	1942
Rebuilt as Chicago pile 2	do	do	Research	1943
Oak Ridge X-10 area reactor	do	Oak Ridge, Tenn	Isotope production.	1943
Hanford 305 test reactor	do	Hanford, Wash	Testing	1944
Hanford (8 reactors)	do	do	Production	1944
Brookhaven National Laboratory.	do	Upton, N. Y	Research	1950
Thermal test reactor	do	Schenectady, N. Y	do	1951
Sodium reactor experiment	AEC, NAA	Santa Susanna, Calif.	Power prototype	1956
Nebraska group	Consumers Public Power District.	Nebraska	Power	1959
Holyoke	City of Holyoke, Mass.	Vicinity Holyoke, Mass.	do	1960

LIQUID METAL FUEL REACTORS

Liquid metal fueled reactor	AEC	Brookhaven, N. Y	Research-power	1959
Orlando	City of Orlando, Fla.	Vicinity, Orlando, Fla.	Power	1960

FAST BREEDER REACTORS

Experimental breeder reactor 1.	AEC	Arco, Idaho	Research	1951
Experimental breeder reactor	do	do	Power prototype	1959
Power Reactor Development Co.	Power Reactor Development Co.	Monroe, Mich	Power	1960

ORGANIC MODERATED REACTORS

Organic moderated reactor	AEC	Arco, Idaho	Research-power	1957
Piqua	City of Piqua, Ohio	Vicinity Piqua, Ohio	Power	1960

VARIOUS TYPE REACTORS

Los Alamos fast Clementine (dismantled).	AEC	Los Alamos, N. Mex	Research	1946
Sodium intermediate reactor: Mark A	do	West Milton, N. Y	Land-based prototype submarine.	1955
Mark B	do	Submarine *Sea Wolf*	Submarine	[1]
Aircraft reactor experiment	Not stated	Not stated	Experimental	[1]

TYPE NOT YET SELECTED

Florida group	Not stated	Tampa Bay area	Power	1962–63

[1] Not stated.

Sources: Nuclear reactor data prepared by Raytheon Manufacturing Co., November 1955; releases, Atomic Energy Commission; semiannual reports, Atomic Energy Commission; various newspaper and magazine sources.

Nuclear reactors in the world—completed, under development, planned, or applied for

Country	Pressurized water	Boiling water	Swimming pool	Homogeneous	Heavy water	Graphite	Liquid metal	Fast breeder	Organic moderated	Various types	Not specified	Total
U. S. S. R.	2				1	4					[1] 10	[1] 17
India			1									1
Switzerland			1		1							2
Canada					4							4
France					2	2						4
Norway-Holland					2							2
Sweden					1							1
Britain					2	16		2			8	28
Italy					1							1
Australia					1							1
Belgium						1						1
West Germany						1						1
Total, excluding United States	2		2		15	24		2			18	63
United States	14	7	13	15	11	17	2	3	2	4	1	89

[1] Including U. S. S. R.'s 5-year program (1956–60) during which time they claim they will build 10 different types of reactors. Data on types not available.

NOTE.—Basic source for this data was primarily from publication of Raytheon Manufacturing Co., Nuclear Reactor Data, November 1955. Other sources were also used. Of the data in its publication, Nuclear Reactor Data, Raytheon Manufacturing Co. said the following:

"This chart has been compiled by the nuclear power group of the Raytheon Manufacturing Co. to provide a comprehensive outline of the reactor field during its first 13 years. All known reactor projects throughout the world are represented—whether in actual operation, under construction, or in the late planning stage. Practically all of the basic data now available are believed to be included."

Nuclear power plants—Investor-owned utilities participation

Organization	Reactor type	Capacity	Estimated investment by organization	In operation by	Status as of May 16
		Kilowatts	*Millions*		
Duquesne Light Co.	Pressurized water	[1] 100,000	$15	1957	Construction half completed. Reactor due to go critical in summer of 1957.
Consolidated Edison	Pressurized water thorium-uranium converter.	[2] 236,000	55	1960	Construction permit issued May 4, 1956. Site procured. Studies, research and engineering underway. Construction scheduled to start in summer of 1956.
Nuclear Power Group (7 utility companies).	Boiling water	180,000	45	1960	Do.
Pennsylvania Power & Light Co.	Homogeneous	[3] 150,000	(4)	1962	Announced in July 1955 intention to build homogeneous reactor by 1962. Carrying on various studies, research and development and engineering.
Power Reactor Development Co. (18 utility companies).	Fast breeder	100,000	55	1960	Proposal accepted by AEC as basis for negotiation of contract Aug. 8, 1955. Construction permit applied for Jan. 6, 1956. Studies, research and engineering underway. Construction tentatively scheduled to start August 1956.
Yankee Atomic Electric Co.	Pressurized water	134,000	3.4	1959 or 1960	Proposal accepted by AEC as basis for negotiation of contract, Feb. 8, 1956. Site procured. Studies, research and engineering underway. Construction tentatively scheduled to start in spring of 1957.
Florida Group (3 utility companies).	Not stated	[5] 200,000	[5] 50	1962 or 1963	Announced in March 1956, intention to build reactor by 1962–63. Carrying on various studies to determine best reactor.
Pacific Gas & Electric	Boiling water	5,000	[5] 1.5	1957	Construction permit issued May 15, 1956. Site procured. Studies, research and engineering underway. Construction to start in 1956.
Southern California Edison Co.	Sodium graphite	[5] 7,500	1	1956	Construction about completed. Due in operation in 1956.
Total		1,112,500	[6] 305.2		

[1] 60,000 kilowatts initially.
[2] Oil-fired superheater to contribute 96,000 kilowatts of the 236,000 kilowatts.
[3] Minimum.
[4] Not stated.
[5] Preliminary estimate as reported.
[6] Included in this figure are an estimate for the Pennsylvania Power & Light plant based on an average cost and 11.8 million research costs by Atomic Power Development Associates, Inc.

NUCLEAR POWER GROUP

American Gas & Electric Service Corp.
Commonwealth Edison Co.
Central Illinois Light Co.
Illinois Power Co.
Kansas City Power & Light Co.
Pacific Gas & Electric Co.
Union Electric Company of Missouri

YANKEE ATOMIC ELECTRIC CO.

Boston Edison Co.
Cambridge Electric Light Co.
Central Maine Power Co.
Central Vermont Public Service Corp.
Connecticut Light & Power Co.
Connecticut Power Co.
Hartford Electric Light Co.
Montaup Electric Co.
New Bedford Gas & Edison Light Co.
New England Power Co.
Public Service Company of New Hampshire
Western Massachusetts Electric Co.

POWER REACTOR DEVELOPMENT CO.

Alabama Power Co.
Central Hudson Gas & Electric Corp.
Cincinnati Gas & Electric Co.
Columbus & Southern Ohio Electric Co.
Consumers Power Co.
Delaware Power & Light Co.
Detroit Edison Co.
Georgia Power Co.
Gulf Power Co.
Iowa-Illinois Gas & Electric Co.
Long Island Lighting Co.
Mississippi Power Co.
Philadelphia Electric Co.
Potomac Electric Power Co.
Rochester Gas & Electric Corp.
Southern Services Inc.
Toledo Edison Co.
Wisconsin Electric Power Co.

FLORIDA POWER GROUP

Florida Power Corp.
Florida Power & Light Co.
Tampa Electric Co.

AEC Access Permits

INVESTOR-OWNED ELECTRIC UTILITIES ISSUED THROUGH MARCH 1956

Alabama Power Co.
American Gas & Electric Co.
Arizona Public Service Co.
Atlantic City Electric Co.
Atomic Power Development Associates, Inc.
Baltimore Gas & Electric Co.
Boston Edison Co.
Cambridge Electric Light Co.
Carolina Power & Light Co.
Central Hudson Gas & Electric Corp.
Central Illinois Light Co.
Central Illinois Public Service Co.
Central Louisiana Electric Co.
Central Maine Power Co.
Central Power & Light Co.
Central & South West Corp.
Central Vermont Public Service Corp.
Cincinnati Gas & Electric Co.
Cleveland Electric Illuminating Co.
Commonwealth Edison Co.
Community Public Service Co.
Connecticut Power Co.
Connecticut Light & Power Co.
Consolidated Edison Company of New York, Inc.
Consumers Power Co.
Dallas Power & Light Co.
Detroit Edison Co.
Duke Power Co.
Eastern Utilities Associates
Empire District Electric Co.
Florida Power Corp.
Florida Power & Light Co.
General Public Utilities Corp.
Georgia Power Co.
Gulf Power Co.
Hartford Electric Light Co.
Holyoke Water Power Co.
Houston Lighting & Power Co.
Idaho Power Co.
Illinois Power Co.
Indianapolis Power & Light Co.
Interstate Power Co.
Iowa Electric Light & Power Co.
Iowa Power & Light Co.
Iowa Public Service Co.
Iowa Southern Utilities Co.
Iowa-Illinois Gas & Electric Co.
Jersey Central Power & Light Co.
Kansas City Power & Light Co.
Kansas Gas & Electric Co.
Kansas Power & Light Co.
Kentucky Utilities Co.
Long Island Lighting Co.
Middle South Utilities, Inc.
Metropolitan Edison Co.
Mississippi Power Co.
Monogahela Power Co.
Montana Power Co.
New Bedford Gas & Edison Light Co.
New England Electric System
New Jersey Power & Light Co.
New York State Electric & Gas Corp.
Niagara Mohawk Power Corp.
Northern Indiana Public Service Co.
Nuclear Power Group
Ohio Edison Co.
Otter Tail Power Co.
Pacific Gas & Electric Co.
Pennsylvania Electric Co.
Pennsylvania Power & Light Co.
Philadelphia Electric Co.
Portland General Electric Co.

INVESTOR-OWNED ELECTRIC UTILITIES ISSUED THROUGH MARCH 1950—continued

Potomac Edison Co.
Potomac Electric Power Co.
Power Reactor Development Co.
Public Service Company of Colorado
Public Service Company of Indiana, Inc
Public Service Company of New Hampshire
Public Service Company of New Mexico
Public Service Company of Oklahoma
Public Service Electric & Gas Co.
Puget Sound Power & Light Co.
Rochester Gas & Electric Co.
South Carolina Electric & Gas Co.
Southern California Edison Co.
Southern Services, Inc.
Southwestern Gas & Electric Co.
Tampa Electric Co.
Texas Electric Service Co.
Texas Power & Light Co.
Texas Utilities Co.
Toledo Edison Co.
United Gas Improvement Co. (Lucerne division)
Union Electric Company of Missouri
United Illuminating Co.
Utah Power & Light Co.
Virginia Electric & Power Co.
West Penn Electric Co.
West Penn Power Co.
West Texas Utilities Co.
Western Light & Telephone Co.
Western Massachusetts Electric Co.
Wisconsin Electric Power Co.
Wisconsin-Michigan Power Co.
Wisconsin Power & Light Co.
Yankee Atomic Electric Co.

Mr. LINDSETH. Supporters of S. 2725 seem to lose sight of the existence of these numerous United States reactor projects and programs. One of these—the power demonstration reactor program—is serving to achieve the very same objective which S. 2725 has. Either under this program or through straight license applications, reactors are planned for each of the reactor concepts in the AEC's 5-year power reactor development program which appear ready for demonstration, and numerous smaller reactors of these and other designs are in progress. We are opposed to spending tax dollars merely to duplicate projects already under way.

Many references to an atomic power race with other nations are noted in the press and elsewhere. In this connection, we suggest that the objectives of our Nation's nuclear power program be examined. One such objective must be to help assure an abundant domestic supply of electric power at reasonable rates.

In this regard, we should take note of our starting point in comparison with that of other world powers. In 1954, the national average use of electricity was 3,353 kilowatt-hours for every man, woman, and child in the United States. The comparable per capita use was approximately 1,569 kilowatt-hours for Great Britain and 664 kilowatt-hours for Russia.

Our challenge in this country is largely one of economics—not quantity at any cost. Ours is not a problem of scarcity of electric power, nor one of near-term scarcity of fossil fuels and waterpower.

Available evidence indicates that other world powers generally have totally different conditions regarding power and fuel sources. Great Britain, due to coal depletion on the one hand and the need for weapons materials on the other, seems to need reactors now and therefore, is stressing quantity rather than quality.

In pursuance of that need, Great Britain has made known plans to build a dozen or so dual-purpose reactors all of similar design, one which is considered technically obsolete in this country. Can this approach be expected to achieve any lasting advantage in the so-called "race" for world atomic leadership by contrast to our approach of seeking continuing progress in efficiency and cost reduction? We think not.

Another objective of our program should be to enable the United States to take the lead in helping countries which lack economical supplies of fossil fuels and waterpower to develop atomic power on a sound basis. Here again it would seem to us that such an objective could best be met by proceeding in a businesslike manner to develop efficient, economical power reactors that will be able to compete in international markets on their own merits.

That the United States already has achieved a preeminent position in this field is evidenced by the delivery of a swimming-pool reactor to Switzerland and the agreements which American manufacturers have made with the Belgian syndicate for delivery of a power reactor and with the Governments of Brazil, Japan, Spain, and Italy for delivery of research reactors.

It was disclosed in the Wall Street Journal this very morning that two American manufacturers, International General Electric Co., and North American Aviation Co., were each chosen to build a 10,000 kilowatt power reactor by American and foreign power companies for installation in Latin America.

Decision on a third reactor is under study. A total of 6 American manufacturers bid on these 10,000 kilowatt reactors.

No other nation approaches the position of the United States in regard to progress in foreign markets.

From the start, the United States has been the world leader in technological advances in the generation and transmission of electricity. These advances are continuing at a relatively fast rate and we intend to make them available to all our customers and the Nation as rapidly as developed, just as we always have.

One of our major objectives in entering the atomic power field on a broad scale is to seek ways to lower still further the cost of generating power, for the ultimate benefit of our customers. The driving force behind our striving for continued technological improvement, both in convention and in nuclear plants is our desire to bring to our customers and the Nation an ever-increasing quantity of power at the lowest possible price. Collaterally, we are confident that our continued world leadership in power technology will enable our country to maintain its preeminent position in the field of assisting have-not nations.

In our testimony at the March 6 hearing, we took note of the objectionable features of sections 44 and 182 (c) in the 1954 act. We wish to repeat our previous position that these preference clauses are completely unfair. In a recent Senate debate, appearing on page 6318 of the Congressional Record, it was stated:

> If the benefits come from governmentally constructed reactors such benefits are then available to all companies, all concerns, all citizens alike.

Quite the contrary is the case. The un-American preference clause, as contained in the Atomic Energy Act of 1954, operates in reverse. Section 44 of the act states in part:

> * * * In contracting for the disposal of such energy the Commission shall give preference and priority to public bodies and cooperatives or to privately owned utilities providing electric utility services to high-cost areas not being served by public bodies or cooperatives.

By reason of the preference clause of the 1954 act and its application to S. 2725, 80 percent of America's power users would be discriminated against, even though the portion of the Federal taxes they, in effect,

pay through their electric rates would help finance the plants called for by the bill.

Such discrimination should be done away with rather than fostered through needless building of Government power reactors, as proposed by the bill under consideration. As the New York Times stated it so aptly in an editorial dated May 16, 1956:

> The preference clause is unfair, and seems to us to invite socialization of the power distribution business.

It has been testified before the Joint Committee that Government demonstration reactors would provide a "yardstick" measurement of construction and operating costs for nuclear powerplants. Existing Government-owned power projects fail to include any cost component for Federal income taxes such as would be payable if the project were investor-owned.

In addition, the largest Government project, the Tennessee Valley Authority, pays nothing to the United States Treasury on appropriations representing capital employed, and includes only token State and local tax equivalents as a cost component in its rates.

Since taxes and cost of money together take an average of 37 cents of each dollar of revenue received by investor-owned electric utilities, and since such charges are relatively minor for Government power operations, how can such a "yardstick" be a true measure of the cost of producing power for industrial and commercial purposes? The answer, of course, is that such a "yardstick" cannot be and is not a true measure. It never has been.

In summary, we ask the question—what is the advantage in building with taxpayers' funds an additional six power reactors at this stage of the art? We believe there is no advantage that could come anywhere near justifying the required expenditure of public funds and the diversion of valuable technical manpower and materials from other projects.

One of the primary disadvantages is that such a Government construction program generally would duplicate work already underway. In addition, we believe that little or nothing would be gained timewise. The time required to design, develop and construct a reactor is such that, even if the Congress passed S. 2725 today, we doubt that the reactors built thereunder would be completed prior to those private industry projects now in the advanced stage of planning, unless under the guise of a "crash" program, priority as to materials and manpower were proclaimed for Gore bill reactors in preference to those already progressing.

We believe that the present AEC and industry program for atomic power development is in keeping with the recommendation of the McKinney panel that—

> atomic power should be exploited as a source of electrical power at a rate consistent with sound technological, economic and public policy considerations.

Quality, not mere quantity, is being and should continue to be stressed.

We view the program envisaged by S. 2725 as duplicative, unnecessary, and wasteful of taxpayers' dollars and technical manpower. Moreover, S. 2725 would, in our opinion, put still another agency of the United States Government in the tax-exempt electric-power business on a commercial basis in competition with taxpaying, investor-owned electric companies.

The very words of the bill—

In selecting sites for each facility the Commission shall consider * * * the need for additional electric generating capacity in the region of the site under consideration—

confirm this belief.

The Atomic Energy Act of 1954 ended the Government monopoly and opened the door to private participation in the atomic field because private enterprise is our way of life and because it was known from experience in countless fields that private industry could make a real contribution to the solution of atomic problems. Private enterprise has accepted this challenge with enthusiasm and is proceeding on a sound, logical basis.

Under the AEC and industry programs in progress, each reactor type that appears to have promise for commercial use is being developed by one or more projects. Utilities in conjunction with the equipment manufacturers are making noteworthy progress in the development of nuclear power. With continuation of our present efforts we believe the United States can and will maintain its world leadership in power and reactor technology.

Gentlemen, I thank you again for affording the Edison Electric Institute an opportunity to appear before your committee, and on behalf of Southern California Edison, I ask leave to have inserted in the record, as we have arranged, this statement on behalf of Southern California Edison which describes the progress on a 7,500-kilowatt capacity steam generator to be built in association with the sodium reactor experiment at Santa Susana, which generator will be ready for operation October 1 this year.

Senator JACKSON. I believe the Chair granted permission for the inclusion of the Southern California Edison statement.

Mr. LINDSETH. Fine; thank you.

(The statements of Messrs. Clapp and Quinton follow:)

STATEMENT ON BEHALF OF FLORIDA NUCLEAR POWER GROUP BY WILLIAM J. CLAPP, PRESIDENT, FLORIDA POWER CORP.

My name is William J. Clapp. I am president of Florida Power Corp., an investor-owned utility serving 31 counties in Florida and through a subsidiary, the Georgia Power & Light Co., 19 counties in south Georgia. I am speaking on behalf of the Florida Nuclear Power Group, of which Florida Power Corp. is a member, along with Florida Power & Light Co., and Tampa Electric Co. These other companies are also investor-owned, and the 3 companies together supply electric power to three-quarters of the total population of the State of Florida, or about 3 million people. The total assets of the three companies are some $700 million.

We have always been interested in the prospects for nuclear power. Several years ago when the AEC was looking for utility companies to operate the pressurized water reactor in the 5-year reactor development program, we establish an informal committee to investigate the feasibility of utilization of nuclear fuels. Since then, each company has applied for and received an access permit.

Recently, as you know, the three companies and Allis-Chalmers Manufacturing Co. and the Babcock & Wilcox Co. formed the Florida Nuclear Power Group. An agreement has been signed which states in part, "The purpose of this agreement is to confirm previous conversations and particularly the understanding reached at conferences between representatives of the Florida companies and the manufacturers to participate actively in the advancement of the art and science of nuclear power in Florida. The project to be undertaken by the Florida companies and the manufacturers under this agreement is the investigation, design, construction, and operation of a large nuclear powerplant to be located at an appropriate site to be acquired in the State of Florida within suitable transmission distance of the systems of all three Florida companies. The bismuth-graphite

reactor will be studied, together with other types of reactors, to determine technical and economic feasibility."

The Florida Nuclear Power Group believes that the Atomic Energy Act of 1954 has created a favorable atmosphere for the development of nuclear power by private industry and that industry is responding to the challenge with initiative and ingenuity. It must be remembered that projects of the magnitude of the Consolidated Edison and the Commonwealth Edison, for which construction permits have recently been granted, require a mammoth amount of detailed planning and design work before equipment fabrication and construction begin. In any new venture of an engineering nature, many months are consumed in research, design, engineering, programing the work, and training personnel. From the time of the inception of a conventional generating plant, it takes at least 3 years before it can be put in operation. When the special problems inherent in the atomic energy field are added to the usual problems, it is really remarkable that as much progress is being made as has been indicated in recent testimony before this committee hearing.

The Florida Nuclear Power Group intends to follow the pattern set by the Consolidated Edison and Commonwealth Edison projects. At present we are thinking in terms of a large-scale high-temperature reactor which might go into operation, serving all three systems, in 1962. This means that we will have to complete our development work and finalize our design by 1958.

Analysis and evaluation of the various promising reactor types is in progress. We are fortunate in that our associates in this project, Babcock & Wilcox and Allis-Chalmers, and our consultants, Stone & Webster, can bring to bear on this evaluation the accumulated experience of a large number of technical experts skilled in nuclear reactor technology, and of course, in the conventional steam powerplant arts. By the end of 1957, we anticipate that 300,000 man-hours of engineering and research and development work will have been accomplished. Our manufacturers and consultants are associated or connected with almost every reactor project which is expected to contribute to the development of atomic power.

Application is being made to the Georgia Institute of Technology for time on their electric transmission network analyzer for the Florida companies to make a joint system study to determine the proper site location from a transmission standpoint. This will be done not later than September of this year. Factors such as meteorology, hydrology, geology, and seismology will then have to be considered. This will require considerable time in addition to the development and design time already mentioned.

We want to make a real contribution to the reactor art when we expend the sizable amounts of money and scarce manpower required for a project of this magnitude. We believe that we can accomplish these objectives with reasonable success under the present legislative situation, providing certain changes already suggested by industrial representatives are made. The Government going into the atomic power generating business will not remove the limitations to progress in the nuclear power field. They will still be the same—i. e., manpower, technological development, pilot-plant testing, materials, and hazards evaluation.

Statement on Behalf of Southern California Edison Co. By Harold Quinton, President

My name is Harold Quinton. I am president of Southern California Edison Co., with general offices at 601 West Fifth Street, Los Angeles, Calif. Edison Co. is a public utility corporation engaged in the business of generating, purchasing, transmitting, distributing, and selling electric energy in portions of central and southern California. The population of the territory served by the company is estimated to be approximately 3,800,000 persons. At the present time, meters installed on the Edison system total 1,380,000.

The company is subject to the jurisdiction of the Public Utilities Commission of the State of California, and is also subject to certain provisions of the Federal Power Act, both as a licensee of the Federal Power Commission and as a company engaged in the transmission of electric energy in interstate commerce.

On or about June 13, 1955, the Southern California Edison Co. offered to participate in the reactor development program announced by the United States Atomic Energy Commission, hereinafter called the Commission, by proposing to build at the company's sole cost the necessary electric generating facilities

and to purchase from the Commission the surplus heat energy developed incident to the operation of the research and development facilities of the Commission at the sodium reactor experiment plant at Santa Susana, Calif., hereinafter called the SRE plant.

On or about November 9, 1955, the company was advised by North American Aviation, Inc. (hereinafter called North American) that North American had received from the San Francisco operations office of the Atomic Energy Commission written confirmation that they approved the plan of the Southern California Edison Co. and, because of the urgency of being permitted to proceed with such construction so as to permit the receiving of large pieces of equipment that were on order and to prevent further delays in the proposed construction schedule, authorized the Southern California Edison Co. at its own risk to commence the installation proposed by Edison and Edison proceeded to do so. Thereafter Edison learned of the acceptance by the Commission of its proposal subject to the negotiation of a formal contract. Negotiations for such formal contract have been proceeding since and it is believed that the terms thereof are now substantially agreed upon.

Southern California Edison Co., among other things and subject to the terms and conditions of said contract will agree—

1. to design, install, operate and maintain at its sole expense and without cost to the Government or its contractor all of equipment material, and facilities which are necessary for the safe and reasonably efficient conversion of the surplus heat developed at said SRE plant to generate electric energy for serving customers of Edison Co.;

2. to pay the Commission for surplus heat energy developed at the SRE plant and supplied to the company's steam generator at the rate of 45 cents per million B. t. u.'s of heat;

3. to cooperate in every reasonable way with the Commission and with North American in any training program and in permitting the representatives of other utilities, both investor owned and publicly owned, to participate in the engineering, operating, and maintenance phases of the project under company control, in the manner and to the extent permitted by the Commission and North American.

We realized at the time we made our proposal to the Commission that this project would not provide an economical power supply. But, it was our objective to obtain information, technical knowledge, and practical experience pertaining to the use of nuclear power for civilian purposes by participating actively in the project so as to make a substantial contribution of services, materials, and facilities necessary to the project, which we believe will be of value to this field of technology and to the entire electrical industry, all in the public interest.

The company also recognized that this SRE experimental utilization facility is one of scientific and engineering experimentation, research and development, and that continuity of its operation is of vital importance to the Commission. Therefore, the Edison Co. intends to install and operate equipment which will be new and of good design and quality and which shall provide high reliability of service.

We estimate that the total cost of the project, exclusive of the cost of purchased heat energy and exclusive of operation and maintenance expense, will exceed $1 million.

The company commenced construction of the project on or about November 10, 1955, and has been proceeding with due diligence in the construction and completion of said project. It is our sincere belief that, barring unforeseen difficulties, all of the steam electric generating equipment will be ready for operation on or about October 1, 1956, and prior to the time heat energy will be available from the SRE plant.

In conclusion, it is my opinion:

1. That the project being installed and financed by Southern California Edison Co. will contribute importantly to the technology and practicability of generating electric energy by the sodium graphite type of reactor.

2. That private industry should carry on a substantial part of the research and development program on nuclear power facilities for the production of electric power and that it is not necessary for the Government to enter into any program for the construction of large demonstration reactors with the taxpayers' money as proposed by S. 2725. The interest and activity of investor-owned electric utility companies and the commitments already made by such companies in the nuclear power program clearly indicate the willingness and

ability of the investor-owned electric industry to undertake a major responsibility for the commercial development by private capital of nuclear power facilities for the generation of electric energy.

3. The number of qualified scientific and technical personnel now available for work on reactor programs is limited. Therefore, if the Government were to enter into an additional program for the construction of large demonstration reactors as proposed by S. 2725 it would necessarily result in an added dilution of scientific and technical talent now fully employed. The coordination and cooperation which exists today in private industry by the joint use of the services of scientific and technical personnel results in the maximum utilization of such talent. Under Government operation, a serious question would arise as to the practicability, and perhaps even the legality, of the utilization in private industry of the services of scientific and technical personnel engaged in a governmental undertaking.

I wish to thank you for the opportunity to appear before your committee and present my views.

Senator JACKSON. You wish to have the matters appended to your statement included as a part of your statement?

Mr. LINDSETH. Yes, if they might be printed with the statement I would appreciate it.

Senator JACKSON. They will be included in the record at the point where you referred to them.

Mr. LINDSETH. Thank you.

Senator JACKSON. Senator Gore?

Senator GORE. Mr. Lindseth, by way of demonstrating whether or not this list of 89 which you have cited is mostly of the test-tube variety, would you be so kind as to point out one single power reactor, except for Shippingport, the nuclear portion of which is financed largely by the Government, and a reactor to produce weapon materials or military propulsion, that has been constructed or on which construction has even started to generate power in as much as 5,000 kilowatts?

Mr. LINDSETH. In an exchange with one of the members of the committee, there was a question asked as to the power capacity of the *Nautilus* reactor and the Chairman of the Commission said the matter was classified.

Senator GORE. I excluded that in my question. I excluded a reactor for military propulsion.

Mr. LINDSETH. I misinterpreted your question. The 5,000 kilowatt qualification would disqualify EBR–1, the first reactor in the country or in the world to produce electric power, because its capacity was less than 5,000 kilowatts.

Senator GORE. Will you be so kind as to point out one if you can?

Senator JACKSON. I think the one you just referred to, Mr. Lindseth, was built by the Government anyway.

Mr. LINDSETH. Oh, to be sure.

Senator JACKSON. He is, I think, referring to any privately built reactor.

Senator GORE. I am referring to either Government or private.

Mr. LINDSETH. To my knowledge, there is no reactor other than a military reactor producing power in the amounts which Senator Gore has limited the question to, 5,000 kilowatts.

Senator GORE. I want to limit my questions because there are other witnesses. Do you know of a single electric utility which has served as

the principal contractor for the Government in the construction of a single reactor for power purposes?

Mr. LINDSETH. No; I do not.

Senator GORE. Why, then, do you assume that this should be primarily the prerogative of the utility industry?

Mr. LINDSETH. Sir, I hope I didn't use the word "prerogative."

Senator GORE. I did not assess you with that. That was my word. I didn't mean to, at least, and if I improperly did so, I apologize.

Mr. LINDSETH. We have spoken about the American way of industrial and technical progress. All of us, you in your speeches on the Senate floor, and the testimony, have spoken very favorably about the free enterprise system in which you thoroughly believe, so we believe together in the objectives.

It is not that a question should be raised that there is a prerogative of business to do something which the Nation has charged business with from its beginning and under which we have achieved our greatness.

The question is: Why should we do it otherwise? The burden of our statement is that progress under the conventional and traditional American system is adequate and encouraging, and our objection to the bill is not in its objectives, which seek the development of low-cost electric power, which is our firm objective. We are together on the objectives.

Our sole difference is on the method, and it is S. 2725 which proposes that we achieve the objective by methods which we think are un-American and contrary to our history and traditions.

Senator GORE. You don't really mean to say "un-American"?

Senator JACKSON. Do you think the preference clause is un-American?

Mr. LINDSETH. I do; yes, sir.

Senator JACKSON. Teddy Roosevelt was the one who offered that amendment originally, you know, to the Reclamation Act back in 1902. Do you think he was un-American?

Mr. LINDSETH. I think the consequence of what was done has developed an un-American practice.

Senator JACKSON. You think all of those who voted for the preference clause, therefore, I follow logically, are un-American.

Mr. LINDSETH. No, sir; but I submit that the consequence of their vote is to put into the American statutes and in the public power practices an un-American and a discriminatory practice which favors the minority of the American citizens at the expense of the majority.

Senator JACKSON. Private utilities have done pretty well under the preference clause. In the Northwest they are buying most of our power generated by the Government. As a matter of fact, they are making money now. In the old days when they operated under their system with watered stock and before we had the Holding Company Act, they were in real trouble and the people who invested in those companies in the Northwest lost their shirts.

Today they are making money and they are buying it from Government-owned dams. I don't know of any socialization that has taken place there. As a matter of fact, the only State where you don't have a single private utility is what State, Mr. Lindseth? You are well versed on the subject, and I am not, so I just want to ask you.

Mr. LINDSETH. Nebraska, sir.

Senator JACKSON. Did the Federal Government or the preference clause bring that about, Mr. Lindseth?

Mr. LINDSETH. I am sorry, I am not familiar with the details of what caused the evolution in Nebraska.

Senator JACKSON. Wait a minute. I just want to ask you to answer the question: Did the preference clause that started with Teddy Roosevelt bring about a situation where there is not a single privately owned utility in that State?

Mr. LINDSETH. I am sorry, and I am embarrassed, but I just don't know the answer to the question.

Senator JACKSON. You know that it is a fact that at the time the utilities were taken over in the State of Nebraska by reason of a State law; isn't that right?

Mr. LINDSETH. I am sorry; I don't know that either.

Senator JACKSON. What is your title? You are representing the Edison Electric Institute?

Mr. LINDSETH. Yes, sir.

Senator JACKSON. Aren't you pretty well versed in private utility operations?

Mr. LINDSETH. That is a relative term, sir, and I am embarrassed to say I am not competent to review the history of Nebraska public power.

Senator JACKSON. I think you will find, if you do a little researching—and if you want to file a statement on that you may—that the preference clause had nothing to do with it.

Mr. LINDSETH. It is entirely possible and I just don't know about it.

Senator BRICKER. Those in Nebraska are city-owned, I believe.

Senator JACKSON. Governor, I think you will find that they have a setup that is more or less cooperatively owned. They are allowed to set up their own cooperative by reason of State law.

Senator BRICKER. However, most of the distribution plants in Nebraska are owned by the cities.

Senator JACKSON. Both, I think.

Senator BRICKER. Many States have that situation. We have it in our constitution in Ohio, and yet we have very few of them that are city-owned.

Senator JACKSON. I think the record will disclose, Mr. Lindseth, under the preference clause the private utilities have been able to buy power, and I think they should. It hasn't resulted in socialization at all. The troubles the utilities have had have stemmed right from the grassroots. Some of the most conservative elements in America, the farm groups, have moved in on the utilities with what they thought were the abuses, right or wrong.

Senator GORE. Mr. Chairman——

Senator JACKSON. That is all.

Senator GORE. Mr. Lindseth, my questions were not intended to be antagonistic to you or the industry you represent. I think I can make my point in a statement quicker than questions.

I sought to call to your attention the fact that the electrical utility industry had not been depended upon by the Government to develop nuclear science. I was attempting to call to your attention that the

electric utility industry is by no means the best qualified by reason of experience in this field.

There are other segments of our industrial life that have had more experience, more competency, more technical experience, and attainments in this field than the electric utility industry.

That is not meant to be an indictment of the electrical utility industry. Your industry is essentially an electrical generation and distribution industry. The construction of an atomic power reactor is quite a different thing from the standpoint of technology.

Your statement, of course, is a long statement and a well-prepared statement from your point of view. There are a number of statements on which we could have some discussion, I hope, to the possible enlightenment of each of us. I will refer to but one.

On page 9 you say that this program which I propose generally would duplicate work already underway. If that be the case, it would be the fault of the Atomic Energy Commission. I have not proposed any duplication. I have tried to make it plain that it was to be entirely supplementary.

There are so many promising processes and methods which are not being tried, which are not being exploited, and in which we are not obtaining experience in actual construction, but I think there is a vast field in which the Government can operate. My only serious doubt about the program is whether it should be confined to six.

I only make that comment with respect to your sentence on the top of page 9, and I thank you very much for your courtesy.

Senator JACKSON. Senator Bricker?

Senator BRICKER. I have no questions.

Senator JACKSON. Senator Pastore?

Senator PASTORE. I haven't had the opportunity, sir, of listening to your statement, but I have been trying to pick up fragments here from one of the members of the staff, and I think that you directed some statements toward the preference clause.

Do you feel that if we have a preference clause at all, in equity and justice to all segments of the country this preference clause ought to also include those sections of the country that don't have the boon and bounty of public or hydro-electric power, but must be confined strictly to private power, and that they ought to be considered, too, considering the fact that the rates there might be higher than other parts of the country?

Do I make my question clear?

Mr. LINDSETH. With one minor clarification. When you say those areas considered, you mean for possible Gore reactors, Government-built?

Senator PASTORE. Yes, if we are going to have them at all.

Mr. LINDSETH. Sir, that is a hypothetical question which presupposes, I presume, that we are going to have these reactors and we are now locating them in the country.

Senator GORE. I don't mind you indulging in that presumption.

Mr. LINDSETH. There was a witness here last week who said, "If you will grant my assumptions * * * ".

Senator PASTORE. I realize the position you have taken. You have taken the position, as I understand it, that heretofore the progress has been satisfactory on the part of private industry. There are some of

us who are somewhat concerned that other rival countries might outdistance us in this race.

There, of course, we have a dispute. We have a sense of controversy as to who is right and who is wrong. Mr. Gore takes the position that he is not opposed to the development of this art on the part of private industry, but he feels that not quite enough has been done, that there are certain obstacles in our way, and for that reason there must be governmental participation.

There are some who feel that private industry can do it alone. Up in our part of the country we have the Yankee Atomic Energy Co. that does receive a subsidy from the Federal Government. They have applied for it. They are a group of private companies. They don't see any harm in some kind of public subsidy in order to do this job, because there is a research benefit for the entire nation.

There are other people who feel that Government alone ought to do this. Mr. Gore takes the position that private industry ought to do it and that supplemental to that we ought to get this show on the road, we ought to do everything possible, and that the Government ought to participate, too, by building these six reactors.

All I am asking is: In the event that the Congress takes that point of view—I am not asking you to take it—and does appropriate the money for these additional six reactors, then do you feel that if there is any preference to be given at all, the private companies should be considered, too, on behalf of those consumers who live in areas where the cost of electricity is very high?

I am speaking now of New England. I come from New England where we don't have public power, where we don't have the REA's or the cooperatives, particularly in the State of Rhode Island, and constantly I pick up advertisements throughout the country that are trying to attract industry from our regions and to go to those sections of the country that enjoy public power because power there seems to be cheaper.

While I don't want to get into that debate at all, I think it is an unfair situation to have taxpayers' money used in order to generate cheap power in certain parts of the country and have that contribution made by other regions when they are going to take the chance of losing their industries. That is the point I make.

I am asking you in working out these preference clauses whether or not all factors ought to be taken into account and whether or not the high rates in some private utility company service sections we ought to have under consideration also.

Mr. LINDSETH. As we testified—and our committee has expressed itself in connection with section 182(c) of the act—our opposition to preference does not relate to the position which Senator Pastore has here expressed because it does specify there that preference should also be extended first to those areas where fuel costs, and therefore power costs, are the highest.

Senator PASTORE. I remind you, sir, that that was my amendment.

Mr. LINDSETH. Very good, sir. We do not take issue with that.

Senator PASTORE. That is all.

Senator JACKSON. Are there any other questions?

Senator BRICKER. Can you see any reason for any preference clause to anybody? Public power in certain places is perfectly efficient and

recognized as a part of the whole power development program. Private development has been more extensive, of course.

In the light of that fact, all of them legitimately and legally operating, is there any reason for any preference clause of any kind or character?

Mr. LINDSETH. We think not.

Senator BRICKER. That is all.

Senator JACKSON. Mr. Lindseth, do you support the Shippingport formula?

Mr. LINDSETH. By formula you mean a reactor to be owned by the Government and the sale of the steam to a utility?

Senator JACKSON. You are familiar with the setup there. The Government by and large paid for the cost of the reactor, or is directing the reactor construction, but private enterprise, of course, is building the power generating facilities and will operate the reactor.

Mr. LINDSETH. Because Shippingport was authorized before the 1954 amendment, it was probably the only feasible way in which a large reactor could be built and associated with a utility, because of the restrictive provisions before the 1954 amendment.

There was no alternative in those days. There is an alternative today and the Shippingport formula, if that was the word you used, is not as favorable for the Government or for the United States for the advancement of nuclear power development as are reactors under the power demonstration program or under the licensing provisions of 1954.

Senator JACKSON. I take it, then, that you would oppose that formula in the future.

Mr. LINDSETH. We would offer as an alternative a preferable arrangement such as Consolidated Edison, Commonwealth Edison, Yankee, or Atomic Power Development Associates.

Senator JACKSON. Thank you. We appreciate having your statement.

Our next and last witnesses, this morning are William F. Schnitzler, secretary-treasurer of the AFL–CIO and Andrew J. Biemiller, legislative representative of the AFL–CIO.

Will there be separate statements?

STATEMENT OF WILLIAM F. SCHNITZLER, SECRETARY-TREASURER, AFL–CIO; AND ANDREW J. BIEMILLER, LEGISLATIVE REPRESENTATIVE, AFL–CIO

Mr. BIEMILLER. No.

Senator JACKSON. Mr. Schnitzler, we are pleased to have you here this morning, and we will let you proceed in your own way.

Mr. SCHNITZLER. Chairman Jackson and members of the Joint Committee on Atomic Energy, I am William F. Schnitzler, secretary-treasurer of the American Federation of Labor and Congress of Industrial Organizations. I am accompanied by Mr. Andrew J. Biemiller, one of our legislative representatives, and Mr. Leo Goodman, of our research department, who is working on atomic energy matters.

Organized labor has been actively interested in the whole subject of atomic energy ever since the first military use—the explosion of a fission bomb burst this science into public knowledge. Prior to our

merger in December 1955, each of the segments, the AFL and the CIO, had established by action of their highest legislative bodies a special committee to represent organized labor's interest in the nuclear science field, not only in the collective bargaining sense, but also as citizens actively participating in government, our interest extends to the question of broad public policy regarding the impact of this new science on American life and all of modern civilization.

When the first atomic energy legislation was before the Congress organized labor participated in the extensive debate which occurred throughout the length and breadth of this land on the question of the direction which this new science would take.

You will recall the great debate as to civilian versus military control, which resulted in the enactment of the McMahon bill, the Atomic Energy Act of 1946, to vest primary control in civilian authorities.

I would note in passing that one of the witnesses for the military position at that time—the then Deputy Chairman of the Army, Navy Munitions Board and Special Assistant to the Secretary of the Navy, Rear Admiral Lewis L. Strauss, who is now Chairman of the Atomic Energy Commission.

One of the first resolutions which was adopted by our merger convention in New York in December 1955 was a resolution on atomic energy. I understand this resolution was placed before this committee on March 6, 1956, during the hearings on the development, growth and state of the atomic energy industry, and I request its full text be incorporated in my statement at this point.

Senator JACKSON. Without objection, it will be so included.

(The resolution referred to follows:)

AFL–CIO CONVENTION RESOLUTION

ATOMIC ENERGY

Developments in atomic science have reached the stage of technologically translating theoretical scientific knowledge into increasingly practical peaceful application. A widening impact on most of industry can be expected soon.

At the Geneva Conference on the Peaceful Uses of Atomic Energy an impetus to early application of many uses was given by broadened declassification of secret atomic information and a freer exchange of scientific discoveries than had existed in many years. Further developments along this line will undoubtedly result from the establishment of an international agency on atomic energy, which is now under active consideration by the United Nations.

To organized labor these developments provide an opportunity and a challenge to serve as a public interest force seeking the maximum application of this new science and industry for the broadest beneficial uses for all of mankind. Organized labor must act also to assure maintenance of adequate protection from harmful radiation both for workmen exposed to radioactive materials and for the general public.

The worldwide importance of the growing application of nuclear science led the free trade unions of the world, through the International Confederation of Free Trade Unions, to convene an International Conference on the Peaceful Uses of Atomic Energy in Brussels, Belgium, last August, just prior to the Geneva Atomic Conference. The ICFTU conferees, while supporting the measures taken by various governments and the United Nations, called especial attention to the need for:

Democratic control over the production and use of atomic energy;

The association of the free trade unions with such control;

The application of all necessary safety measures in plants extracting and producing fissionable materials, producing atomic energy and using its products;

The insuring of high social standards in plant extracting and producing fissionable materials and atomic energy, with the cooperation of the free trade unions, in the first place by means of collective bargaining;

Adequate safeguards for the rights and interests of the workers wherever displacement of manpower might result from atomic developments.

Here in the United States, where the greatest investment of public funds has been made in developing this new technology, action for more rapid and broadened application of peaceful uses of nuclear science must be urged upon the Atomic Energy Commission.

After several years of hesitation, the Commission finally in the past year has been nudged into stepping up the pace of both government and private development for peaceful purposes, but still is proceeding slowly and, as far as the public is concerned, largely in the dark.

In stimulating a more aggressive program of development for civilian uses, the AEC and the Nation must remain alert to the danger of commercial monopoly. The Government must vigorously enforce its authority to prevent any firm from using patent rights to gain monopolistic control of any important phase of nuclear development.

A relatively few industrial giants have had the opportunity as contractors for the Government in the military development phases of the atomic program to gain special know-how and personnel in this complex field. They must not be allowed to convert their head start or inside knowledge into an unduly favored position or exclusive control of any aspect of private application.

The widening of private activity in this field must take place on a truly competitive basis to bring to the American people the benefits to which their investment in atomic energy entitles them. The Government must therefore encourage participation by as wide a variety of responsible private enterprises as practicable and must assure such enterprises an equal opportunity through appropriate provisions for access to necessary atomic information and resources: Now, therefore, be it

Resolved, The AFL-CIO urges the following as fundamental elements in an enlightened United States atomic energy program in the best interests of the American public and the world as a whole:

1. The United States should participate wholeheartedly in the formation and operation of an international agency on atomic energy adhering to the principles urged upon the members of the United Nations by the ICFTU.

2. The United States should encourage, and participate in, regional agreements under the United Nations Charter to make possible for several countries within the appropriate region to assure mutual availability of capital, technical know-how and equipment, as well as to develop common programs in whose benefits all would share.

3. Development of peaceful uses of the atom should be promoted as rapidly, fully, and equitably as possible, to hasten the day when the atom's potential is reflected in improved standards of living for all.

4. The tasks of overcoming technological obstacles and of putting atomic energy into practical everyday civilian use in this country, including the construction of large-scale power reactors, must be carried through both by the Federal Government itself and by expanded participation of private enterprise.

5. In encouraging broadened participation by private industry, the Federal Government must not relinquish its responsibility to assure that atomic energy is developed and applied in the public interest and under standards established and maintained to that end. Federal policy must prevent the development of monopoly in any aspect of this new industry.

Full consideration must be given to the probable need for Federal standards to be established either through the licensing power of the Atomic Energy Commission or by legislation.

6. Since expanded peacetime atomic development will have a marked economic and social impact, its likely effects must be weighed carefully in advance and a program must be drawn to meet the human needs arising out of any dislocation of existing industry.

7. The public must be kept informed fully of the Nation's peacetime atomic plans and progress. The program of easing and eliminating secrecy restrictions on nonmilitary technical information must be greatly accelerated.

8. The growth of atomic energy operations requires that particular attention be directed to the development of—

(*a*) A sound labor-management relations program, with maximum emphasis on free collective bargaining as an integral part of broadened private enterprise.

(*b*) Effective health and safety standards to meet the special hazards presented in work with radioactive materials.

(c) Provisions for fair compensation for workmen suffering radiation injury.

(d) A voluntary manpower program to assure a necessary supply of competent skilled labor to meet our atomic needs.

9. A statutory labor-management advisory committee should be established to advise the Atomic Energy Commission in developing these programs.

Committee Secretary SODERSTROM: I move adoption of the resolution.

The motion was seconded and carried.

Mr. SCHNITZLER. Today we are particularly interested in resolves Nos. 3 and 4, which read:

3. Development of peaceful uses of the atom should be promoted as rapidly, fully, and equitably as possible, to hasten the day when the atom's potential is reflected in improved standards of living for all.

4. The tasks of overcoming technological obstacles and of putting atomic energy into practical everyday civilian use in this country, including the construction of large-scale power reactors, must be carried through both by the Federal Government itself and by expanded participation of private enterprise.

Numerous of our affiliated international unions that have been meeting recently in conventions are showing growing interest and are adopting resolutions concerning the development of atomic energy for peacetime uses.

The evidence continues to accumulate, Mr. Chairman, that further action is needed to implement these two resolves. But, Mr. Chairman, the evidence of the lack of action here is made doubly poin'ed by the growth of significant developments abroad. I assumed, Mr. Chairman, when I read the monthly journal of the British Trade Union Congress for April 1955, that it was pardonable pride which resulted in their title, "In the Atom Race Britain Sets the Pace." Since writing this yesterday, I note in this morning's paper further releases of the development in Britain.

I was quizzical when I noted their paragraph which reads:

In the United States there is talk of supplying New York with power and light through atomic energy but there is no evidence that it is any more than newspaper talk.

Then I was encouraged when the next month the British Labor Movement noted, and I quote: "America enters race to use atom power." The British Government program announced in February of last year for 12 reactors, has since been bolstered with an announcement for a total of 22, and the first plant at Calder Hall is virtually completed. My British trade-union friends advise me that electric power will go into the grid either late this year or early in 1957.

Mr. Chairman, the chairman of the British atomic power program when visiting here recently, stated that Great Britain had six dual-purpose reactors already under construction. There is report of real progress in France. And now the stories of atomic progress out of the great dictatorship, the Soviet Union, come every day.

I have not seen, nor do I know, how to credit the quality of work which they are doing, but thousands of our members read the newspapers published around our own atomic-energy installations and they believe them. I hold in my hand a copy of the Oak Ridger, published at the home of the atomic-energy industry.

The issue of May 18, 1956, just last Friday, has a front page heading: "United States Scientists Describe A-Facilities as 'Terrific,' " and the article, and I read only one paragraph:

Western scientists have been given a look at the Soviet Union's hitherto top secret atomic smashing laboratory.

Said one American, and I quote: "Absolutely first-class work."

The Christian Science Monitor says:

> Soviet leaders harness the atom to propaganda—

and there is no doubt that the Soviet dictatorship will take propaganda advantage of any gain which they make in this field. But if we are to credit the responsible observers we must acknowledge the size of the program in which they are engaged in applying the knowledge they have in nuclear science, however they got it, to the latest developments in this industry.

The Monitor says they intend to accomplish the installation of between 2 and 2½ million kilowatts by 1960. This goal exceeds the British program of 2 million kilowatts by 1965. The program in the United States falls tragically below both figures.

In trying to understand why this has happened, we turned to some of the leading scientists in this field and we found some explanation in the statement of Mr. Alvin Weinberg, the Director of the Oak Ridge National Laboratory. He asked at a recent meeting of the atomic industrial forum, and again I quote:

> Why is it that in this country our large-scale power demonstration program cannot be launched on the same scale as the demonstration program of our competitors?

He answered:

> The reasons are really not hard to find. They center primarily around the fact that at the moment the economic incentives to go into large-scale power reactor development are not sufficiently apparent to make such development a really good short-term bet.

The question, therefore, is very simple. If high power costs give the British an incentive to go ahead and propaganda value impels the Soviet into a big program, and the Director of the Oak Ridge National Laboratory is right that economic incentives are not sufficiently apparent to move the program here in the United States, are we going to be left at the gate?

Speaking in behalf of organized labor, I urge that this committee see that the United States is not left behind.

I urge that we do not sit here endlessly debating whether more concessions and subsidies are needed to spur private industry into action. The gentlemen of the utility industry assured us that if the Congress would pass the 1954 Atomic Energy Act, opening the way for participation of industry in the peaceful application of the atom, we could expect immediate action.

Instead, these same people have come back to this committee repeatedly asking for one concession or subsidy after another. But the net result in the way of action has been the construction of one reactor largely with Government funds and the granting of two construction permits. Actual work has not yet started on these last two reactors.

Frankly, Mr. Chairman, the labor movement is becoming most disturbed over the lack of action. Once preeminent in the atomic field, we seem to have lost the initiative. It is high time we regained it—it is high time to get at the core of the matter and get immediate action. We urge your committee and the Congress to instruct the AEC to proceed forthwith as vigorous and determined a program for peaceful application of atomic energy as our scientists are able to develop.

This is not the time to argue ideologies. This is the time to show our American initiative and get the job done.

The Gore bill, S. 2725, provides the basis for committee action. This committee has already held extensive hearings on:

1. The McKinney Panel report.
2. Statutory hearings on the development, growth and state of the atomic energy industry.
3. Proposals for Government indemnity insurance.

The Subcommittee of the Interstate and Foreign Commerce has held extensive hearings on proposals relating to exemption of utilities engaging in atomic reactor building from the Public Utility Holding Company Act of 1935.

There have been full and adequate hearings. What is needed is a little action.

I do not pretend, Mr. Chairman, nor does organized labor seek to adopt the role of scientific advisor to this committee, but we do know the political facts of life. Our neighbor to the north, with far less resources than we have, talks of developing the most advanced reactor in the world for testing power systems to go into operation in 1956. Can we afford to continue to lag?

We of labor are ready to do our part. The kind of crash program urged by Commissioner Murray and authorized by the Gore bill has our support. May we remind the committee that we did our part in the crash program that developed the atom bomb.

With no previous experience as we now have, we helped assemble and train a working force that started from scratch and built a tremendous plant for the most stupendous scientific achievement in history. We can do it again, particularly if the committee will set up by legislation the kind of joint labor-management advisory, committee that functioned so successfully as an integral part of the War Manpower Commission during the war.

In closing, Mr. Chairman, I should like to make this point. No organization in America, or in the world for that matter, has a more honorable record of constant and vigilant opposition to the Communist conspiracy than the AFL–CIO.

We shall be relentless in continuing that opposition. But we are becoming exasperated with the failure of our Government to take the initiative in so many fields. We wait to see what the Russians are going to do and then formulate our policy.

Let us drop this attitude, at least in the atomic field. Let us again seize the initiative and take all necessary steps to bring the potential blessing of the new source of energy to not only our own people but those of the entire free world. Let us as the leaders of the free world be the ones who bring these blessings to the underdeveloped countries so badly in need of energy. Let us not wait until Russian developments force us into action.

Let us show the world that the first democracy of the modern world—the United States of America—can mobilize its scientists, its workers, it managerial skills, its resources, to truly harness the atom for peaceful uses and bring a higher standard of living to peoples everywhere.

The passage of the Gore bill, Mr. Chairman, would be an important step for freedom-loving people everywhere. We trust that your committee will report the bill promptly.

Senator JACKSON. Mr. Schnitzler, the Chair would like to congratulate you on the clarity of your analysis of the problem, and the brevity of your presentation, and the constructive suggestions you have made.

Senator Gore?

Senator GORE. I will yield to Senator Pastore.

Senator PASTORE. I join with Mr. Jackson in complimenting you for what I consider to be a very concise, clear and constructive statement. I do want to say that I more or less enjoy the same apprehensions, if that is the proper phraseology, as you do. I am somewhat surprised sometimes to listen to the advocates of private industry—and I fundamentally believe in our system of free enterprise—who take the position that government should be out of this field because they are now ready to assume full responsibility.

I go along with Senator Gore, who has said that this job must be done. It is a question of approach. It is a question of whether we are doing all that we possibly can do in order to match the rivalry that confronts us, particularly from a regimented nation like Russia, and a socialized nation when it comes to electricity on the part of the United Kingdom, that decides on the top what they are going to do and how much money they are going to put in this, not only to win the hearts of the world, but also to capture the international markets of the world, and I think myself that we have reached the point now where we must in the Congress determine exactly whether we have gained the proper pace and whether we are maintaining the proper pace.

We have a group proposal—and I am glad to see that Mr. Cisler is in this room today—and they have now created what is the Atomic Power Development Co., and I think, if I remember correctly, that that represents about 40 percent of the entire electrical output in this country.

If it is true that 40 percent of the entire electrical output of this country is building one breeder reactor, we can only hope to have 2½ reactors, if my multiplication is correct, as against the 22 that you are talking about in England.

I say that the question that confronts us is precisely this: If there is participation on the part of the Government in this research field—and that is the reason why I feel that the Government belongs in it, because it is still a research field—I see no encroachment here on private industry.

We are not building these reactors today so as to sell electricity to various parts of the world. All we are doing is engaging in the research and the development of this art, and unless we build reactors, we don't know what the bugs are in them. We don't know how far we can go in the development of this particular field.

However, the thing that concerns me most is this: Government, to be sure, should not engage itself in this field if it means that we are going to retard the whole program, and the question before us is: Is private industry at the present time equipped? Is private industry capable? Has private industry the money to do what is necessary to be done in order to match this rivalry that is met with in socialized and regimented nations, and the best figures that we have indicate that we have now proposals before us amounting to $200 million or $300 million.

I submit that is not enough. We spend maybe 5 times that amount of money to help to build up the economies of other countries of the world in 1 year, and here we are where we are confronted with a cataclysmic project, one that might turn the entire mode of living of mankind overnight, the production of power through the use of nuclear energy, and what are we prepared to give up in the devolpment of this field?

About $200 million or $300 million. And industry comes in here and says that is enough. If this were strictly a question of building reactors after we have established a prototype, I think the argument would carry some validity, but we are in a research field and if we develop this research we will be aiding private industry and private industry should welcome this participation on the part of the Federal Government, unless it deters their own actions.

Certainly the United States Government is not going to build reactors to sell electric current and nationalize our entire industry. I think the CIO and the AFL would be against that. I think their public utility workers, their electrical workers, would be against a socialized program because they, too, want to operate in a free market that is guided by collective bargaining and they are not ready and willing to give that up either.

However, I do subscribe to what you said, sir. That as long as we are in this competition, as long as we have private industry only putting up $200 million or $300 million, which is a sizable amount, but yet not quite enough, when we look around us and see what is taking place on the other side of the ocean, I think that private industry ought to in this instance actually encourage the Federal Government to pursue its research activities to build these reactors if it means better research in order that we can join hands and maintain the leadership in the world which is absolutely necessary if we are to keep it.

Senator JACKSON. Senator Pastore, I know I subscribe to just what you have said. I think you have made an excellent statement of the problem the committee is up against and what we should be doing about it.

Senator Bricker?

Senator BRICKER. I have no questions.

Senator JACKSON. Senator Gore?

Senator GORE. Mr. Chairman, I want to join with you in complimenting Senator Pastore on his statement. It was comparatively brief, but I think you will agree, Mr. Schnitzler, comprehensive.

If the stenographer does a good job of punctuation, it will need no revision. It was excellent, and I thank you for your statement.

I would like to call to your attention, Mr. Schnitzler, since you made some references to the propaganda efforts of the communistic conspiracy, that the United States alone has used the atom for destruction. It would seem, though I, like you, claim no competence in this field, from what I have read and from what members of your organizations and you have read, that the Soviets are undertaking to brand the United States as a warmonger, as a nation dedicated to the development of atomic science for war purposes, for destructive purposes, and let me ask this of you: What effect do you think it would have in the field of international prestige, propaganda, and political appeal, particularly since it was on the yellow man that the

atom was dropped, if 4 years from now the Soviet Union is generating 3 to 5 times as much atomic power as is the United States?

Mr. SCHNITZLER. Tremendous. We participate in numerous conventions of international organizations representative of the free labor movements of the world, and in every one of those conventions we find ourselves confronted with numerous resolutions.

The organized workers of Japan always have a resolution to eliminate the use of atomic weapons during a war and keep reciting what happened to them. Other nations that are fearful that we might use it on them come up with resolutions, too, wanting to outlaw the use of atomic bombs, and in every instance the concentration of what is directed at us is just as you say, that we use the atom for war purposes, not for peace purposes. During these last few months everything that has come out of Russia dwells on the peaceful development of atomic energy and talking about what they are doing, and how they are now the great nation in the world leading the world in the peaceful uses of atomic energy, and here we sit with nothing to counterattack this propaganda after we had first developed the atomic energy here in this country.

The members of our unions, the officers of our unions throughout the country, are concerned with this, because they acknowledge that this is going on at the present time. We think that when you talk about building six reactors, it isn't quite what we think ought to be done. We don't know enough about this field to say whether it should be 6, 16, 26, or possibly 60.

We should build as many different kinds of reactors as it is possible for our scientists to develop so that we can finally get down to using what we consider to be the best. However, in the face of this opposition, it appears to us that there is sort of suspicion cast at our Congress and our Government that in developing these reactors for peaceful use, maybe the Congress or the Government may have something else in mind that may be directed against private enterprise or private industry.

Now everybody knows where the AFL and CIO stood as individual federations on the question of private enterprise. They know where we stand now and we have none of those suspicions. We are interested in getting this program going.

We are interested in us getting as much use out of this new development as is humanly possible for the good of the people of our country, and for the good of the people in the free world who will be partners of ours in the fight for freedom, and we must get it going.

We are way past the talking stage, way past the talking stage. I heard a witness for industry this morning talking about the people that the industry serves as being a representative part of the statement.

I don't believe that because I am one of the users of electric power and I wasn't consulted as to whether I am part of that statement, absolutely not. Then they talk about what they are planning to do. Well, they keep saying to the labor movement, "You represent 15 million members." Well, that is so, but if we take the same line, possibly we are planning for 40 million members, whether we have that right now, and could say that we are speaking for 40 million.

We don't have 40 million. We have 15 million. We can only speak for what we have, and if the industry will make the same approach

to this problem as we do, then they will only be able to talk of what they have, not on the planning that they are doing way off into the future that gives you absolutely no guaranties.

This is a serious problem. This is an important problem, a problem in which we have to give everything that we can to hold the initiative so that some day, as we are constantly faced with the Communist menace, we know more about it than any other country in the world.

There is no organization, no society, no peoples anywhere that know more about communism than we do, because we are in daily contact with it, fighting it every step of the way day in and day out. You can never rest for a moment. To rest for just a moment gives them an advantage of some kind.

We are getting to the point where, I might say, we get sick and tired of hearing the same thing, that we have to do this because Russia is doing it. By God, when are we going to get out in the front and let the Russians over there use as part of their argument, "We've got to get going because the United States is ahead of us."

Let's get the United States up in the position where it belongs. We say we are the leader. It has been forced on us or given to us, or whatever expression you would use. We are the leader of the free world and instead of leading, we are always chasing somebody else and not quite catching up.

Senator JACKSON. Senator Pastore?

Senator PASTORE. I don't want to take any more time because, after all, I have consumed quite a bit of time and the hour is running late, but I think that sometimes we ought to put these things in proper focus.

The President of the United States is offering 20,000 kilograms of pure uranium for domestic use and there is 20,000 plus 200 kilograms for international use in conformity with this idea of the international agency, of which he spoke before the United Nations in December of 1953.

I am told that this uranium is worth about $1 billion. That is, $1,000 million, and the big question is that we don't have the reactors to put this uranium in and to manufacture the power that must be manufactured. As I said at another meeting today, it is like giving a person without arms a baseball bat and asking him to hit a home run.

You have to have a place to put this uranium in order to build the power. When I was at the United Nations this last fall to attend the Assembly as a delegate on the United States team, all the representatives of the nations of the world talked about atomic energy, the peaceful use of atomic energy.

In other words, the world is conscious of the potentiality and of the power of this tremendous force of nature, and what are we doing here? When you put it in proper focus, private industry has already not dedicated, but talked in figures of $200 million or $300 million.

Do you realize that that is what it cost us just to build the aircraft carrier *Forrestal*? That is how much we are doing in the field of this one thing which will guide the destiny of man and I hope one day remove the causes of war.

We are putting up no more than it cost us to build one aircraft carrier.

Mr. SCHNITZLER. That is over a period of 5 or 6 years. That isn't 1 year.

Senator PASTORE. And that is America's effort. If anybody can stand here and tell me that that is adequate progress, then I am afraid I have learned nothing on this committee for the last 3 years.

Senator GORE. You see, Mr. Schnitzler, and hear why I am hesitant to enter any battle on the floor of the United States Senate unless Senator Pastore is with me.

Mr. SCHNITZLER. We are glad to hear he is with you on this, Senator Gore.

Senator GORE. You used a word just before Senator Pastore's statement that I want to revert to: "use"; you mentioned that you wanted to come to the point that we could "use" this resource for the benefit of our people. That, of course, is a field in which you, I take it, are more competent than in the international field.

I certainly feel that way with respect to myself. Is not electricity now the lifeblood of modern industry?

Mr. SCHNITZLER. It certainly is.

Senator GORE. Do you know of a community that can obtain the location of an industry without a supply of electricity?

Mr. SCHNITZLER. No, sir.

Senator GORE. Do you know of an industry that can be established without the use of electricity?

Mr. SCHNITZLER. No, sir.

Senator GORE. That being so, do you not think it is of tremendous importance to the economic future of this country in its comparative relations with its sister nations of the world to have available an abundant source of power at the lowest possible economic rate?

Mr. SCHNITZLER. I think our entire future standard of living and the future of our entire Nation is wrapped around that statement.

Senator GORE. That being true, you feel then, I take it from your statement, that not only from the standpoint of maintaining our international leadership in the political world and economic leadership, but merely from the standpoint of retaining our industrial capacity and economic advantage or economic equality with the industry of other nations, we cannot afford to fail to exploit fully this very promising source of cheaper power in the future?

Mr. SCHNITZLER. You are absolutely right, Mr. Senator.

Senator GORE. I am glad to have you on my side, too. Thank you very much. Your testimony has been fine.

Senator PASTORE (presiding). If there are no further questions, we shall recess until 2 o'clock in this same room.

(Whereupon, at 12:45 p. m., the Joint Committee recessed, to reconvene at 2 p. m., the same day.)

AFTERNOON SESSION

Senator PASTORE (presiding). Our first witness this afternoon is Mr. McCune. All right, Mr. McCune. If you are ready, we are and you may proceed in your own fashion.

STATEMENT OF FRANCIS K. McCUNE, VICE PRESIDENT, GENERAL ELECTRIC CO.

Mr. McCUNE. Thank you, Senator. My name is Francis K. McCune. I represent the General Electric Co.

The present hearings are devoted to gathering information about this country's progress in atomic energy. This is your obligation under the law. The country and the atomic industry should count themselves fortunate that you have been so zealous in discharging this obligation. I hope that my testimony today will help you in making the judgments which can be so important to our future in this field.

The interest of General Electric in atomic energy is of long standing. Our research laboratory scientists were among the pioneers in atomic research. We made substantial contributions to the work of the Manhattan District during the war. For a decade we have conducted, on behalf of the Commission, some of its major defense programs.

However, our interest in atomic development has never been limited to its military aspects, important as these are. As you know, General Electric was among those who urged upon Congress the passage of the 1954 act. We believed that our country's atomic progress would be accelerated by permitting the free play of the initiative and energies of a large number of people in private business. Subsequent to the passage of the 1954 act, we advocated before you policies designed to draw more companies and individuals into the atomic industry. We told you that we hoped that entry into the atomic business would be as free as possible, that we had grown and prospered in a competitive economy and that we deeply believed in the value of competition.

Working with our own funds we started in 1952 to study very seriously the commercial prospects of atomic electric power generation. As it became clear that the act of 1954 was likely to pass, we increased this effort. Upon the passage of the act, General Electric began major programs in the commercial atomic field. Our Hanford atomic products operation, our aircraft nuclear propulsion department in Cincinnati, and the Knolls atomic power laboratory were dedicated to defense activities. Hence, we added a fourth organizational component, our atomic power equipment department, which is responsible for our civilian business. My purpose today is to tell you what we have been doing in this business and where we stand now.

Currently, our major activity is the design and construction of a 180,000-kilowatt nuclear powerplant, the Dresden station, for Commonwealth Edison Co. of Chicago. This plant will be located about 50 miles southwest of Chicago and is scheduled to be in regular operation before the end of 1960.

I have already testified that the developmental work required to produce this plant, particularly fuel element development, will be very expensive. Unless we obtain substantial future business, we will lose considerable sums on the Dresden station. At the time we contracted to build this plant for Commonwealth, we were well aware of this. We were aware also of the difficult technical problems ahead of us and of the large investments in developmental facilities, these very expensive tools of the trade, which would be required.

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Moreover, when we signed the Commonwealth contract, we faced serious problems in addition to the technical ones. The regulatory and licensing situation was still unsettled. The Commission was just beginning to break down the information barriers. Above all, the liability problem had not been resolved.

Nevertheless, we took on the Dresden station because we were convinced that by so doing, we would serve the long-run interests of our share owners, our responsibilities to the system of private enterprise, and the national interest. Our decision to go forward was also based on the belief that Congress expected this kind of a job to be done by private industry. We had faith that Congress, and particularly this committee, as well as the Commission, wanted to encourage private development and would take all reasonable steps to promote that development.

What have we been doing on the Dresden station? Well, we have in our atomic power equipment department a Commonwealth Edison project. We have assembled in this project some 85 scientists and engineers. This organization is hard at work designing the plant.

I have inserted here in my testimony a photograph of one part of this activity which is presently in San Jose, Calif. Through the window you can see the new plant that we are putting up.

We have enlisted the servies of other company organizational components, such as the large steam turbine-generator department which is designing and which will build the very special turbine-generator for the plant, the medium induction motor department which is working on design of special motors, the carboloy department which is helping us conduct our fuel-element development, the company's general engineering laboratory which is working on instrumentation and on other problems, and our research laboratory which is working on some aspects of fuel-element development and on special irradiation features of this type of reactor. All these organizational units of General Electric are assisting our atomic power equipment department on this job and conducting tests and development.

We have engaged the Bechtel Corp. as engineer-constructor. Bechtel will be responsible for the engineering on the nonnuclear part of the plant and for most of the construction work. They likewise are carrying on major engineering activities. Currently, Bechtel has about 25 engineers working on this job with our Commonwealth project organization. They are engaged in preliminary engineering and layout and are starting on final design on several features of the plant. Under Bechtel's direction subsoil tests at the Dresden site have been conducted. They have developed in detail alternate proposals for enclosing vessels and the optimum design has been selected. Their plans for foundation and erection are essentially complete.

The engineering organizations of Commonwealth Edison and of its associates in the Nuclear Power Group are continually reviewing our progress and offering helpful suggestions based on their extensive experience and high competence. In addition, we have contracted for work by a number of private research organizations.

Battelle Institute is exploring problems on fabrication, irradiation testing and examination after irradiation of different types of fuel elements.

Stanford Research Institute is working on fuel element rupture problems and high flow rate demineralization of water.

National Aluminate Corp. is studying water purification by several alternate methods and waste-disposal problems.

Broadview Laboratories is working on shielding against mishaps fer, and hydrodynamics.

Columbia University is investigating problems relating to long-term corrosion, water decomposition, materials technology, heat transfer, and hydrodynamics.

We plan to let more research contracts as the work progresses.

We have recognized that the economics of the Dresden station require considerable advances over known technology and that these advances in turn require extensive test facilities. Accordingly, we are building at a cost of $500,000 a heat transfer test unit calling for 10,000 kilowatts of electrical energy. This facility will enable us to obtain essential heat transfer data.

You can see in the picture on the next page, the progress on the foundations of this test unit as of May 10.

As soon as we could put together a team to do the job, we also started construction of a small boiling water reactor which will be completed and in operation next year. With allowances for differences in size, this reactor is of the same design as the one to be incorporated in the Dresden station which we are building for Commonwealth Edison. It will have a core of the same characteristics as the one for the Dresden station. Fuel elements will be nearly identical. This small reactor will be used to conduct fundamental tests required for the Dresden station. Here we will get actual experience on the materials and fuels. We will obtain heat transfer data and data on radioactivity carryover. The reactor will also be used to conduct preliminary training of operators and supervisors. This is an essential part of our Commonwealth project activities, and in a sense it is here that the dirt is being turned on the Dresden station.

The next photograph shows the reactor site on the left of the road, and right in the center of it are the foundations for this reactor. The little round excavation in the foreground is where the water tower will be, to provide emergency water cooling.

Chairman ANDERSON. Could you tell me this: This is similar to the one that is being built at Argonne, a small plant? What do you hope to find out there that they are not going to find out at Argonne, a plant that is already underway?

Mr. MCCUNE. The plant is being built for several reasons. One of the most basic is that we have chosen, we believe, the fuel element, in respect to shape, design, construction and material, which we propose to use initially in the Commonwealth plant.

This particular reactor will be so constructed that it will be possible to put a section of that fuel element in. As I recall it, the Dresden reactor will have a 9-foot element. This reactor will have 5 feet of that 9 feet directly in there without change. This is important because that is the very heart of the reactor.

This reactor will have the same general flux distribution throughout the core which we expect to have in the Dresden station. This reactor will operate at exactly the same heat transfer rate in the fuel element to the cooler. This reactor will have the same proportion of boiling

to water. These technical things are true prototypes of our reference design of the Dresden station, which is not true of any other reactor.

Chairman ANDERSON. The size is comparable to the one being built at Argonne?

Mr. MCCUNE. I think this is slightly larger, but I am not sure. Mr Zinn could tell us.

Chairman ANDERSON. The size is about the same.

Mr. MCCUNE. The size is about the same; yes. Its principle is the same, but it seems to me that saying this is the same as the Argonne one is like saying that the DeSoto is the same as a Buick.

Chairman ANDERSON. The DeSoto and the Buick do not produce any striking new theories on power brakes or combustion types. They use the same general types of pistons. They paint them a little differently and design them a little differently, but if you watched the DeSoto built and then watched the Buick built, you would not learn much about the automotive industry by the second one.

Mr. MCCUNE. I think your point is good and I think I probably used a poor analogy. If you have done something before, you build on that. No one has built this kind of reactor in a large size before.

Chairman ANDERSON. The size is the same here now.

Mr. MCCUNE. No, no; I refer to the Dresden station.

Chairman ANDERSON. Oh, yes, sir.

Mr. MCCUNE. There are many components of the Dresden station, for example, such as the control mechanisms, which must be larger in a big station than they would be in a small station. They are not radioactive, let us say. We are building test equipment on the site under which these mechanisms, in several alternate designs, will be tested to see which is the best one to use.

However, when you come down to the heart of the reactor, which is the specific core, there is not any way to test it as a total except to test almost essentially the final thing that you are going to use, unless you gamble that your knowledge already based on dissimilar things is adequate.

In our setup we are quite convinced that this is the most economical way to get the very heart of this reactor on test and running in 1957 and not in 1960. We expect to really have it going, and this, we think, is a very important step in getting ahead with the basic job of having a big reactor right and being sure that 1960 is a nice, firm date, which I think is what you want.

Chairman ANDERSON. The reason for my question, Mr. McCune, happens to be this: That if this is the same general type of reactor that is being built at Argonne, and you still feel you have to have another one because there is some slight change in it in order that you might get the greatest possible progress, what is wrong with the idea that Senator Gore has of trying a few more types than the four that the Commission plans to build?

If it is good for General Electric, why is it not good for the Nation, in other words?

Mr. MCCUNE. I am not sure that I completely follow you on that.

Chairman ANDERSON. You could learn nearly anything that you wanted to learn from the Argonne one, which is almost the same size.

Mr. MCCUNE. I do not think that is the case.

Chairman ANDERSON. You do not think it is almost the same size?

Mr. McCUNE. I do not think we can learn what we need to know from the Argonne reactor.

Chairman ANDERSON. I did not say that. Let us put it this way: You do learn a great many of the things you need to know from the Argonne reactor which is about the same size, but because you have some other idea—and I think it is a fine thing; do not misunderstand me, as I am all in favor of the plant being built near San Jose—or because you have some other concept you would like to try to build in a small size the thing that you hope eventually to put in the Dresden plant, and you think whatever it costs in time, or effort or delay is worthwhile, and I think I agree with you.

If that is so, what is wrong with the Government building a few other plants besides the 4 that we hope finally to emerge with, or maybe 5? They are very similar. What would be wrong with doing a gas-cooled plant so that we might find out whether the British, who put their gas-cooled plant on the line today, or the Russians, who will put their first gas-cooled plant on the line in a couple of years, have something worthwhile?

Mr. McCUNE. That is not a question you answer with yes or no. That was a long question, Senator.

Chairman ANDERSON. It is a long problem.

Mr. McCUNE. As I see it, this is the picture: If you go back some time, you will find that we were looking at a number of types of reactors. The General Electric Co. made a considered opinion or guess, which was that the boiling water type of reactor with the addition of the dual cycle, which is something of our own contribution, could be made into the type of reactor which could go forward quickly and expeditiously.

I could refer you to, I believe, some written statements that it was a little too advanced to do that at the time. We thought not. We thought we could bring it in the immediate picture. Having picked on that, we did what you might call a conceptual design of the big unit. Having picked on a conceptual design of the big unit, we conceived the idea of building a small unit which would get a great deal of data.

We had already made our gamble that the big unit was correct, but we felt that the production of the small unit, specifically designed not to be the best small unit you could make if you just wanted the small unit, but specifically designed to be the seed of the big unit, if you want to put it that way, was the way to proceed, and I think it is.

Chairman ANDERSON. I am not questioning that at all.

Mr. McCUNE. If we made a decision—I am still trying to answer your question squarely—that a reactor other than the types which are going forward was, in fact, presently justified, my guess is, having looked at it carefully and run a conceptual design in the size that we thought ought to be done, we might do well to build just as fast as possible a small reactor, a reactor which really was the design of the big one, and to have it going on before we got the big job built, so as not to delay the big job.

We are not delaying the big job at all. We are just doing this entirely as we do with other testing.

Have I answered the question?

Chairman ANDERSON. I think that answers my question.

In other words, just because you happened to pick this particular design of a boiling-water reactor with a dual cycle does not mean that something else might not work?

What was your second choice?

Mr. McCUNE. What was our second choice at the time?

Chairman ANDERSON. Yes.

Mr. McCUNE. Well, at the time we were studying them all. I am hard put to declare what 2 years ago would have been our second choice when we did not have to pick the second choice, but we were working on three front runners. We were working on this particular type of reactor. We were working on the graphite, and we were looking very carefully at homogeneous reactors.

Out of those, we thought this was the front runner.

Chairman ANDERSON. Let me ask you this, then: You had a boiler-water type which you were going to build. You had a graphite water moderator?

Mr. McCUNE. Yes.

Chairman ANDERSON. You had the water-cooled. You had a homogeneous type of reactor. Is anybody building a homogeneous reactor?

Mr. McCUNE. I did not think at the time, and I do not think now, that we know enough to build a homogeneous reactor with any reasonable prospect of success.

Chairman ANDERSON. They have a small one built at Oak Ridge. They are now building the second small one and if in 2 or 3 years they find it is workable, then they are going to let the Pennsylvania Power & Light build it several years from now, provided Pennsylvania Power & Light designs what they want to build.

Mr. McCUNE. I would hope that if any segment of industry, including ourselves, reaches the opinion that they could put their name and reputation behind a large-scale homogeneous reactor, we would be out looking for business on exactly that reactor and we will the moment we reach that opinion.

We will not wait for 6 months or for 12 months. We will be out fighting for business the moment that we have arrived at that conclusion, but we cannot do it until we can say to the customers, "Our reputation is on this job and we believe it is the right thing to do."

Chairman ANDERSON. I am sure you would be out after it, because I do know that your firm is alert and I am glad that it is.

Let us go to the second one. You said, in addition to the boiling water, the third one would be a graphite water-cooled type. Your firm has had some experience with that, has it not?

Mr. McCUNE. Yes.

Chairman ANDERSON. It is the Hanford type?

Mr. McCUNE. Yes.

Chairman ANDERSON. You have been the manager of the Hanford plant, operator, contractor, or whatever you may call it, have you not?

Mr. McCUNE. Yes.

Chairman ANDERSON. Therefore, you know that that reactor has worked for a long time and worked successfully?

Mr. McCUNE. Yes.

Chairman ANDERSON. It is primarily now engaged in the production of plutonium?

Mr. McCUNE. That is correct.

Chairman ANDERSON. Do you not think that General Electric has the necessary skill to transfer that plutonium to power? Could you not design a power reactor there pretty quickly, knowing all that you do now about the operation of that reactor?

Mr. MCCUNE. I think the situation is this: We did, in fact, run through designs and spend a good deal of our own money on a Hanford type, not a Hanford reactor, but a Hanford-type reactor, for the production of electricity, alone.

We did a good deal of work for the Government on a Hanford reactor based on the economics of producing both plutonium and electricity. In the first activity, that is the Handford-type reactor for electricity alone, we were carrying along in parallel with another type of reactor. At present I will say we believe that the second type, the one we are working on, will beat the first.

Nevertheless, I think it is fair to say, and I think I can say, that the thought of a Hanford-type reactor producing electricity has never been out of our minds. And I think I can say without any question of security that there have been studies and there are studies going forward by us for the Production Division of AEC, looking toward reactors principally for the production of plutonium, but which will also produce electricity.

I am sure that AEC can give you information on that since I do not know just how far I can go in talking on production units.

Chairman ANDERSON. I do not want you, as you know, Mr. McCune, to get outside the borders of security. We discussed this some the other afternoon, and if you feel you are getting there, I would rather you be overly cautious than not cautious at all.

However, there are three types, let us say, out there. There is the present type, which is producing plutonium. We have been discussing the possibility of a type similar to what the British have done at Calder Hall or what the Russians included in their recent statement, namely, a type that would primarily produce power, but secondarily produce plutonium.

I do not know which comes first in Britain, the chicken or the egg, but they are going to produce both at least, and my understanding is that your company did some work in connection with the Government on that.

Furthermore, I think your company at its own expense did what I regard as a very commendable thing, made some studies on the possibility of taking the Hanford-type reactor and producing energy alone, electricity alone.

Mr. MCCUNE. That is correct.

Chairman ANDERSON. If it developed that the studies of General Electric with its fine reputation for careful work should reveal that it was possible to produce electricity alone from a Hanford-type reactor, even though the cost was still somewhat uncertain, and the prospect was sufficiently alluring so that the Federal Government felt it might want to do it, the Atomic Energy Commission seemingly is not able to proceed.

Would you look with favor or disfavor upon a directive to the Atomic Energy Commission to test this out, or would you feel that was properly a matter for their own consideration?

Mr. McCUNE. I have not lost sight of the Hanford-type reactor, obviously.

Chairman ANDERSON. Excuse me. Senator Gore and I are going to have to go to vote. We will be back in not to exceed 10 minutes.

Representative VAN ZANDT. We shall wait until you return.

Chairman ANDERSON. You need not bother with my questions. Will you just go ahead and finish with your report, with such comments as you care to make on the question?

Mr. McCUNE. You want me to continue, then?

Chairman ANDERSON. Yes. We will probably be interrupted several times this afternoon, I think, on votes. I am awfully sorry.

Mr. McCUNE. Shall I continue?

Representative VAN ZANDT (presiding). Kindly proceed.

Mr. McCUNE. On May 4 the Commission issued to Commonwealth Edison a construction permit and an allocation of fuel for the Dresden station. The construction permit and fuel allocation for the small boiling water reactor were issued to General Electric on May 14.

Our present performance and our schedule on the Dresden station can best be summarized in a table.

	Progress as of Apr. 30, 1956	Estimated dates of substantial completion
Reference design	90 percent complete	June 1956.
Scope design	75 percent complete	April 1957.
Research and development (exclusive of fuel).	10 percent complete	December 1957.
Research and development, fuel	do	1965.
Procurement	Completed principal procurement of test equipment and equipment to be tested.	April 1959.
Construction	Foundation test borings complete	September 1959.
Component testing	Test equipment under construction	December 1959.
Plant tests and initial operation		May 1960.

These estimates are, of course, exclusive of the work on the facilities mentioned earlier, including the small boiling-water reactor. Work on these facilities is much further along.

Mr. Gale, the chairman of Commonwealth Edison, testified here a week ago that Commonwealth and its associates in the nuclear power group have already paid General Electric $3,750,000 of the contract price of $45 million. General Electric on its part has already spent or committed all of this amount.

I would like to emphasize here that designing and building a nuclear powerplant is not a task which can be performed overnight. It is not like turning out an automobile on an assembly line.

On the Dresden station we are working out a design which is new and facing problems which have never been solved before. In developing the design of this station we must use our ingenuity and imagination to minimize hazards. We must anticipate and guard against failure of equipment and against human error. We must solve problems relating to design of large pressure vessels, to the effect of corrosion and erosion on reactor and powerplant parts, to changes in the reactor due to fuel burnup and production of fission products, to feed-water purification and treatment, to heat transfer and pressure drop in the reactor, to fail-safe controls and to auxiliary systems. We must so design the plant as to permit contact maintenance of essen-

tially all the equipment. We must develop fuel elements which will permit economical operation of the plant.

The engineering work required to solve these problems is an essential preliminary to construction. It is necessarily a time-consuming process. So far, we have delineated a number of our major problems, solved some of these problems, released portions of the design and started work where we have arrived at solutions, and pressed vigorously the effect to solve the remaining problems. The project is on schedule. We are making progress at the rate which we anticipated.

This progress should be measured not by the quantities of dirt which we have turned over, but by the state of our engineering work and by the millions of dollars we have already spent so that we can do the construction job expeditiously and economically.

Although the Dresden station project is currently our major activity, our atomic power equipment department has been competing for other business, both domestic and international. We expect to expand the activities of this department as the market develops.

Laboratory: In order to meet our commercial commitments, present and prospective, we are building laboratory facilities, the tools of the atomic trade. We have started construction of our Vallecitos Atomic Laboratory on a 1,600-acre site in Alameda County, Calif. The laboratory will be ready in 1957. It will include a so-called hot laboratory for remote handling of radioactive materials and an experimental physics building containing a critical experiment facility.

The small boiling-water reactor, which I have mentioned previously, will also be part of the laboratory. The reactor will be used not only for development on the Dresden station but for development of other reactors as well. In conjunction with a turbine-generator supplied and operated by Pacific Gas & Electric, it will also be used to produce up to 5,000 kilowatts of electricity. It is scheduled for operation in 1957.

Again I have pictures of the site of the laboratory, the state of construction, the schematic layout of the buildings, and the material-testing laboratory, the hole in the ground with its foundation on May 10, and our critical experiment building with the massive concrete blocks that go under to carry the weight of the critical experiment.

The presently planned laboratory facilities will cost $10 million, and we will add other facilities as time goes on. Our annual operating expenses at the laboratory will run into additional millions. Without these privately owned facilities, or equivalent Government facilities, the Dresden station job could not go ahead.

Manufacturing facilities: The manufacturing facilities of our atomic power equipment department are presently located in Schenectady. These facilities are not adequate. This year we will move our manufacturing operations, as well as our department headquarters, to San Jose, Calif., about 20 miles from our laboratory. A new plant is being built in San Jose next to our existing motor plant to provide department headquarters. Very expensive nonradioactive test equipment is also being built on this site. Eventually, we will devote all our San Jose operations to atomic-energy work. These facilities will cost additional millions of dollars.

And I have a photograph of our headquarters building, which is well along, and the type of test equipment that we have in Schenectady

which would be transferred out there, and part of the construction for one of the big test loops at San Jose.

All these activities have been carried on in a situation where our responsibilities to the national defense programs at the Knolls Atomic Power Laboratory, at the aircraft nuclear propulsion department and at Hanford, are engaging some 2,250 of our scientists and engineers. In these areas the requirements of the Government and our competence to meet these requirements are both steadily increasing.

This is General Electric's story. Other companies will undoubtedly appear before you to tell you of their accomplishments and their plans. Here we have a business which in spite of the present difficulties has already absorbed the energies of a large number of companies from many different fields. The great potential of atomic energy in electric power, propulsion, and other fields, is bound to attract still others.

It has been suggested that the situation would be bettered by the immediate construction of a number of full-scale reactors with Government funds. As a manufacturer, my reaction is as follows:

I believe this would even more heavily tax us in the already preponderant and growing Government effort.

Much more important, however, I believe, would be its effect on the manufacturer's long-range plans. A key factor in successful business—almost the key factor—is arriving at the proper market place with the proper goods at the proper time. This takes long-range planning—and spending based on that planning. I believe that if there is confusion as to whether the power industry as presently organized is to be the market place, or whether the Federal Government is to become dominant, this will cause confusion in business plans and hence these plans will be weakened and are likely to be ineffective.

I firmly believe that on the present basis, private industry is on the way to do a job of which you will be proud. Much depends on your decision in this case.

With faith in the long-run possibilities of atomic energy, with the conviction that Congress was determined to encourage private development, the utility industry, equipment suppliers and many others have given a remarkable demonstration of willingness to invest capital and take risks. More companies will enter the field as time goes on. The competition, which is already strenuous, will become more so. Out of this competition, there will come, as there has in the past, the contributions which will maintain and assure this country's lead in atomic energy.

Representative VAN ZANDT. Does that conclude your statement, Mr. McCune?

Mr. MCCUNE. That completes my statement.

Representative VAN ZANDT. The committee will recess for a few moments.

(Brief recess.)

Chairman ANDERSON. We will be in order again.

Thank you, Mr. Van Zandt, for carrying on.

As I understand it, at the end of the statement you did not ask any questions. Do you have any questions, Mr. Van Zandt, that you want to ask?

Representative VAN ZANDT. I have one question, Mr. McCune. Beginning on page 7 you say:

> Mr. Gale, the chairman of Commonwealth Edison, testified here a week ago that Commonwealth and its associates in the Nuclear Power Group have already paid General Electric $3,750,000 of the contract price of $45 million. General Electric on its part has already spent or committed all of this amount.

Is this in the preliminary work alone?

Mr. MCCUNE. Yes.

Representative VAN ZANDT. Have you let any additional contracts?

Mr. MCCUNE. We have signed and sealed our basic contract with the Bechtel Corp.

Representative VAN ZANDT. Are you at liberty to mention the amount involved in the contract?

Chairman ANDERSON. The overall figure is easy enough, is it not?

Mr. MCCUNE. The actual amount of the contract which we signed with Bechtel is a large fraction of the $45 million, but I do not happen to carry the amount in my head.

Representative VAN ZANDT. What I am trying to develop is what portion or percentage of the $45 million have you actually spent or are you obligated for?

Mr. MCCUNE. Just about the $3,750,000, exclusive of the types of things that we have to put in, in our own money, that have nothing to do with the Dresden station, but without which we could not do anything.

Representative VAN ZANDT. That is the answer I wanted. Thank you, Mr. Chairman.

Mr. MCCUNE. If somebody were to pass a law to stop us tomorrow, that money is gone forever. That is what I am saying.

Chairman ANDERSON. Mr. McCune, if these proposals that Senator Gore has in mind in connection with his bill are for prototype developmental reactors, would there be anything in that that would frighten the industry by their construction?

Mr. MCCUNE. I feel this way Senator: Someone has to make a judgment as to whether any given type is a good horse to enter in the race. He does not have to make a judgment that he knows it will win. You do not do that in a horse race, but you have to make a judgment that it is a good horse to enter in the race.

There are two ways to make that decision if a type of reactor is a good horse to enter in the race, then, in most cases at least, to my way of thinking, you would require a prototype which would as expeditiously as possible get you data that was missing to make a better evaluation, or allow you to proceed with the project.

You then come down to the question of the selection as to what types you really say are the entries in the race. In the normal competitive atmosphere, that selection is a joint effort of the buyer and the seller. When the seller thinks he has something that the buyer should buy and when the buyer thinks that he might well buy it and gain advantage by so doing, that specific decision is made. That is going on a hundred million times a day probably.

Let me put it this way: I think that this program has been advanced to the point where that process of selection will bring forward the best candidates in a very satisfactory manner. The alternate is to set up a committee, a person, a commission, and to tell them to make the selec-

tion and not let the buyer-seller relationship make it, but tell somebody else to make it.

I do not believe so strongly in that system, provided that there is a free access to information. We are approaching free access to information. We are getting down that road pretty well. At the time that there was not free access, there was just no alternative but for the Commission to pick prototypes and go ahead. The buyer-seller relationship could not touch it.

However, the law passed in 1954 brought a buyer-seller relationship into this picture. For the long pull, I think that is the way to do it.

As I have said—I tried to say this in my statement—I think that the relationship which industry as a whole has been expecting will guide these choices. I think that is the traditional relationship and I think it utilizes that thing in which this country is strongest, its total industrial strength. It is not stronger in any other area.

I have no objection and, in fact, I think it very desirable that extensive Government laboratories and installations that we have should build prototypes. Without that type of thing going on the ingenuity, the knowledge of the people that are in these laboratories, would be totally inhibited, because they should not just shuffle papers. They have to build prototypes.

I would hope, as the years go on, the prototype which might be done in the Government laboratory would be more and more of the blue-sky type of thing where it is just a long gambler's chance there might be something in it, and that industry would more and more pick up the prototype building on the things where there is not a 100 to 1 shot, but maybe 1 to 10. That is my philosophy.

Chairman ANDERSON. That is what we have been talking about. I do not find myself differing with you a great deal at all. However, I recall in about 1930 or so the Chrysler Corp. came out with an automobile that had a round nose on it and it was not well received by the public, and Chrysler had to retreat, but if you take pictures of those old Cryslers and put them up against the cars that are operating now, you will find that they were only about 25 years ahead of what finally evolved.

I do not say that every automobile company in the country should therefore decide what the type is going to be 25 years from now and try to reach it immediately, and that is why I do not think this program is exactly like ordinary business, but if there is a type of reactor that seems to be a wild shot in the dark, but yet might have great possibilities of working out, and if it is so attractive that a country like England starts to build it and Russia feels that it must know something about it, I just do not see why the United States feels it does not have to know anything about it. We will wait until England and Russia come up with the answer and if they find out it is worthwhile and excellent, then we will change our program and do it.

At the present time, the Atomic Energy Commission has no authority to step out in this field and start building something. We had to take out the Johnson amendment of the Atomic Energy Act of 1954 or there would have been no Atomic Energy Act of 1954. The Commission could not try a new thing if it wanted to.

However, it was passed with a restriction that is not compelling. The Atomic Energy Commission can move in a little bit, but they are

not going out and building these plants. If something came along that a group of fine scientists thought might work, but it was not something that a large organization should pour millions of dollars of its stockholders' money into, I see no real threat to private enterprise in this country by letting one of those be built.

I do not mean 7,500 kilowatts. I mean 30,000 to 50,000 kilowatts. This Calder Hall reactor that became critical last night and is operating today is a 50,000 kilowatt, I believe. It is not a small plant as I saw it. It is a pretty fair-sized one.

Mr. McCUNE. I think you can get agreement for a good deal of what you have said, Senator. I think that the size of a prototype should be a technical determination based on what you are trying to find out, and that could be 1,000 to 30,000, depending on what you are talking about, or none at all.

Could I say something?

Chairman ANDERSON. Surely.

Mr. McCUNE. I think this whole question, which is of concern involves the following: I have had difficulty comparing our program with that of Russia and England. I think everybody does. I do not know much about the Russian program. Some people may. Some may not.

Chairman ANDERSON. The news dispatches today say the Russians are inviting General Twining to come over and look at their military installations. Maybe we can find out about their atomic energy installations.

Mr. McCUNE. I am just stating a fact. I know what I read in the papers.

However, there is this about it: More than 3 years ago I know that I felt, and I know that I said, that there would be grave concern over our situation in electricity generation and that the best thing that this country could do at the time was to concentrate on wedding the electrical production to our plutonium production. That, I think, would have put us in an international situation in which we had a lot of electricity, let us say, and I think that is what is worrying us.

Now, that was debated. There were provisions debated in the 1954 act that could have made it so or not so, but the upshot was that nothing was done, and we have started on the single-purpose road. England went down the dual-purpose road. Russia went down the dual-purpose road. I am convinced totally of that.

Having done that 3 years ago, they are going to get more electricity sooner than we are. Whether that is good or bad is an entirely different situation, but I do not think that is something you redeem at the present time. Those 3 years are gone, and I feel we are putting in about the maximum effort we can in the single-purpose road. I would just like to go ahead as fast as possible and I think that we will get along faster that way than to go back and try to gain the 3 years we last.

Chairman ANDERSON. I do not want to go back, but I say that having made two or three bets and seeing a very attractive horse out on the track, I still sometimes go back and put a little bit on that very attractive horse that I did not know about from the form chart.

I think that is the situation now and I cannot help but feel that it eventually is going to recommend itself to the American people because it would have been, I think, a wise thing to have followed the

counsel and advice that you had 3 years ago of trying a little bit of the dual-purpose pattern.

Now, we are going to have these other reactors. In my opinion there is not any real doubt that Consolidated Edison, and Commonwealth Edison, and Detroit Electric, and the Yankee Atomic Electric Co., and the Consumers group out in Nebraska are going to build reactors. We will learn a great many things from those reactors, but I do not believe we are going to know so much that it would hurt us if we learned a little something from three additional tests that might be made in modest size and without too great an expense and give us three additional bets, one being to try the gas-cooled idea, which may have some possibilities, which permits us to use natural uranium and thereby is perhaps more usable in some countries outside the United States where we would like to sell our reactors and take our technologies, and which I think might be worthwhile.

Secondly, there are two other types, roughly identified as the Hanford type or the Savannah River type, which might be built for power only or for power plus plutonium, which I think would be still more practical. I would hope that the possibility might exist that we could try those.

Mr. McCUNE. There is one of those that is quite close to home, as you know, and on that one I can say work is going on. As far as the British-type of reactor is concerned, I, as a person making a judgment, think it is left at the gate in the international market. I believe that somebody quoted that from a new English magazine the other day.

I got a copy of that and I said, "My goodness, they certainly came out and really said it this time, didn't they?"

I think that is the case. This is where they stand. They are in trouble. They are in trouble in the international situation.

Chairman ANDERSON. I think there are a great many things that have been written that time did not completely confirm. I read a little something about how we should make a hydrogen bomb. I am not in a position to discuss it because it may still be classified, but I think you know enough about what I am referring to, so that if we had followed that route we would have been safely behind the Russians at the present time.

Mr. McCUNE. I know what you are talking about.

Chairman ANDERSON. By mere accident, we turned our direction, and it just could be that while this British publication says they are on the wrong path, they might not be revealing all they know about electricity, either.

Mr. McCUNE. I was not trying to say that because I read an article in a magazine it must be so.

Chairman ANDERSON. I certainly would not want this discussion to appear, Mr. McCune, that you and I are on opposite sides of this fence, because there are few people in the industry that I have more respect for than I do for you, and I think you know that.

Mr. McCUNE. I just think that that particular one is not the kind of bet that we are interested in. If we want to go down that path, I think we can do better. That is the way I feel about it.

Chairman ANDERSON. Are there any other questions?

Representative VAN ZANDT. Yes, Mr. Chairman.

Mr. McCUNE, on page 11 you say this:

"I believe this would even more heavily tax us in the already preponderant and growing Government effort." Would you go into a few details regarding this statement?

Mr. McCUNE. As I pointed out, there are approximately 2,250 General Electric scientists and engineers presently working in the three major Government-owned projects, entirely exclusive of those we have working in our own facilities. That is a very large number of people.

Let us look at these projects as far as this company is concerned. One of them is Hanford. I think I cannot tell you future plans for Hanford. That certainly would be classified, to be really meaningful, but we have more people there today than we have had before and our efficiency per person is not going down. It is going the other way. Our Knolls Atomic Power Laboratory is engaged in a naval propulsion program. The naval propulsion program is just beginning.

We are engaged in the aircraft nuclear propulsion work. As I said sometime ago, I am convinced that useful military outcome is in store for us there. Every day I become more convinced, and you can calculate the result of that in terms of the demand for people. Even today a very large proportion of our scientists and engineers are engaged in these defense programs which are by no means diminishing, nor should they diminish, and my feeling is that we are really having to scrape the barrel to get at the private electrical production work, although we are doing that, too.

That was my point. There is a tremendous demand.

Representative VAN ZANDT. In other words, if this program is written into law, there is a doubt in your mind as to whether or not the personnel is available to do the job without taking highly trained personnel from projects already under way?

Mr. McCUNE. There has been a great deal said about technical manpower limitations. There is no question that technical manpower overall is a limitation. I have yet to find something that cannot be done, provided people want to do it. I am sure it is not so well done when you are stretching your technical manpower to the limit as it is when you have an adequate number of people to put on the job. I think a man is crazy who says you cannot do something because you might not get men, but I think you can say that the total effort suffers somewhere. That is my point.

Representative VAN ZANDT. Thank you.

Mr. McCUNE. In the end you assess total progress 3 years later and this thing is behind, and that is behind, because the decision was made to add another major project.

Chairman ANDERSON. Thank you, Mr. McCune, very much for your testimony.

Mr. Cisler, I apologize to you. That is the call again. I will be back as quickly as I can.

Representative VAN ZANDT. Mr. Cisler, you may proceed with your statement and I will withhold questions until the chairman has returned.

Would you like to mention for the record the names of your associates there with you?

STATEMENT OF WALKER L. CISLER, PRESIDENT, DETROIT EDISON CO.

Mr. CISLER. Yes.

Mr. Chairman and gentlemen, my name is Walker L. Cisler, and I want to thank the committee for its invitation to testify with respect to the civilian power reactor program and Senate bill 2725.

I have with me Mr. Edward Reid, who is counsel for Power Reactor Development Co.; Mr. Robert Hartwell, who is the assistant general manager of the Power Reactor Development Co., and Mr. Harvey A. Fischer, who is Michigan counsel for the Detroit Edison Co., and I am very happy to introduce them to you.

Representative VAN ZANDT. It is a pleasure to have you and your associates here today, Mr. Cisler. Kindly proceed.

Mr. CISLER. As most of you know, I am president of the Detroit Edison Co., which is one member of Power Reactor Development Co., a Michigan nonprofit membership corporation, now engaged in a project to design, build, own, and operate a developmental fast neutron breeder reactor as a part of the Atomic Energy Commission's power demonstration reactor program under section 104 of the Atomic Energy Act of 1954.

As a member of Power Reactor Development Co., the Detroit Edison Co. has but one vote in the conduct of its business.

The main directives expressed in S. 2725 are:

(*a*) The Atomic Energy Commission is authorized and directed to construct six nuclear power facilities designed to demonstrate the practical value of utilization facilities for commercial purposes;

(*b*) Each such nuclear power facility shall, insofar as feasible and practicable, be of a different design;

(*c*) Each facility shall be located in a different geographical section of the United States, and

(*d*) This reactor construction program shall be in addition to the reactor development program now being carried out by private and public groups.

The stated reasons for this bill, as given by the sponsor on April 26, 1956, were:

1. That this country has not kept pace with other countries in the building of atomic power reactors; and

2. That private industry is not responding to the invitation extended by Congress in the enactment of the Atomic Energy Act of 1954.

In my opinion, the facts do not bear out either claim. I am, therefore, strongly opposed to S. 2725 because it creates nothing that is new and gives no authority to the Commission that the Commission does not already have under the present law.

Further, to my mind, strict compliance with S. 2725 would seriously impede most of the development projects now under way rather than advance atomic development, for reasons which I shall hereinafter discuss.

Let me make it perfectly clear here that I do not in any way oppose constructive atomic development, whether it be by private industry or by Government. On the contrary, in common with all others, I believe this development should be encouraged.

I am opposed, however, to activities labeled as atomic power development, which are ill-advised and if carried out would be wasteful of either public or private funds and resources, and which would not significantly advance the art.

I would like to speak first about the claim that the United States is falling behind in atomic power development. Many people from all parts of the world except the Iron Curtain countries visit us in Detroit to talk about our breeder reactor project. All express amazement at the scope and status of the work under way here in the United States.

Earlier this month, a group of British scientists visited the United States for the special purpose of discussing breeder reactors. While in Detroit, a member of the group stated that one of the most valuable results of his trip was a realization of the great extent and broad scope of atomic power development work in the United States. He contrasted the limited atomic power program in Britain, which comprises the Calder Hall installation and several duplicate plants, and 1 breeder reactor project, capacity about 15,000 kilowatts, with the program in the United States which includes many different types of reactors.

The activities in the other Western European countries certainly are no more comprehensive than in Britain

I do not know what the Iron Curtain countries may be doing in atomic power other than what was revealed at the Geneva Conference and has been claimed in various public statements. However, the Russians have not publicly demonstrated, or even reported, anything which compares even remotely with the reactor of the submarine *Nautilus*.

Some of you may know that, as a representative of our Government, I had many contacts with the Russians on power matters during World War II. At that time their technology with respect to thermal plants was many years behind that in the United States. I find it exceedingly difficult to believe that in the few intervening years they have been able to excell us in any aspect of the power business.

It would be a great service to tell the people of the United States what countries exceed our development program and progress, together with supporting facts.

It is manifestly unfair to charge the Atomic Energy Commission with failure to keep our country in the lead unless facts rather than conclusions are given.

From my experience and knowledge of the situation, I am certain that the claims that we are being outdistanced by others in atomic power development are based largely upon somewhat fertile and purposeful imaginations. That does not mean, however, that there is any reason for complacency.

We must continue our efforts to bring about economic nuclear power at the earliest possible time, but we cannot afford to be wasteful in those efforts.

My comments, of course, do not apply to the thermonuclear process. That is a subject about which I have no information.

Now let us examine the statement that too little is being done in the United States.

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Omitting strictly military activities, 14 or more power reactor projects, totaling over 1 million kilowatts of electric generating capacity either are under way or ready to get under way in the United States.

Representative VAN ZANDT. Do you have a list of those somewhere in the report, Mr. Cisler?

Mr. CISLER. I can give you the list of those, Senator.

Representative VAN ZANDT. Mr. Chairman, why not have the list read at this time.

Chairman ANDERSON. You have the list there. You could read them off; could you not?

Mr. CISLER. There is the PWR.

Chairman ANDERSON. What capacity do you assign to that?

Mr. CISLER. That is 60,000 or more kilowatts. HBR–2, which I believe is 15,000 kilowatts; the FRE homogeneous reactor, which I think is of the order of 5,000 kilowatts. The sodium graphite reactor I believe is about 7,500 kilowatts. That is the North American.

And the boiling water reactor 2, which I believe is 5,000 kilowatts, the first 5 being the 5-year reactor development program of the Commission.

Under the power demonstration reactor program, we have the Power Reactor Development Co. breeder reactor of 100,000 kilowatts, and we hoped maybe more; the Consumers Public Power District, which I believe is about 75,000 or 80,000 kilowatts; the Yankee Atomic Electric, which I believe is better than 100,000 kilowatts.

Chairman ANDERSON. We will take 120,000 on that one.

Mr. CISLER. All right.

The Elk River project in Minnesota, which I believe is 22,000; and the Wolverine project in Michigan, which I think is about 10,000 kilowatts.

Then, of course, in addition to these are the Commonwealth Edison project, which is the large boiling water reactor, and that is of the order of 180,000 kilowatts; the Consolidated Edison of New York, which is the pressurized water type with oil fire superheating, reaching up to 250,000 kilowatts.

Chairman ANDERSON. Yes; but some of that is superheated by other devices.

Mr. CISLER. Yes; I say with the oil part superheating.

Chairman ANDERSON. One hundred forty thousand, as far as nuclear energy is concerned.

Mr. CISLER. From the reactor itself, yes. The General Electric Pacific Gas & Electric boiling water reactor, I think is about 5,000 kilowatts, and the Pennsylvania Power & Light, which would be an advanced homogeneous type of reactor, I think of the order of 150,000 kilowatts.

Those are the ones that I have here, Senator Anderson. Of course, there is the proposal on the part of the Florida companies for a unit of up to 200,000.

Chairman ANDERSON. You say either underway or ready to get underway. The Pennsylvania people testified down here and they testified that after 1958 they would be in a position to make a decision as to whether they would get underway.

Mr. CISLER. I think, Senator Anderson, the reason for that is that on all of these projects there has had to be certain research and development work, testing of components, testing of materials, because

we are in a research and development period in this whole business, and from the conceptual design there must occur research and development work, materials, clearing out design, performance, and the like.

We are going through that very period ourselves. We have been doing so for several years, and I hope to cover a typical example of what is necessary to do in order to get into the actual building of a reactor.

I would like to tell you the amount of time and effort and expense which has been made over the past 5 years in bringing this up to the point in this breeder development and getting the design of the reactor and the complete plant that we have brought here for you to see.

Chairman ANDERSON. I just hope we do not somewhat double them up and count them twice. The Oak Ridge item that you put in here is very similar to what the Pennsylvania Power & Light hopes to build, and we have them both in here as plants that are either built or underway. It depends a whole lot upon how much HRE develops at Oak Ridge as to whether Pennsylvania thinks it will go ahead with that type of program.

Similarly, the GE Pacific Gas & Electric, as I understood it, was a forerunner of the Commonwealth proposal. Is that not your understanding?

Mr. CISLER. Yes, it is my understanding, Senator Anderson.

Chairman ANDERSON. Would you not regard the Oak Ridge plant and the Pacific Gas & Electric plant as pilots rather than prototypes?

Mr. CISLER. I would call them prototype plants, leading up to the larger.

Chairman ANDERSON. What would a pilot plant be?

Mr. CISLER. I do not distinguish too much difference between a prototype or a pilot plant. They are much smaller in the case of the pilot plant. The prototype may be a plant somewhat comparable in size, but there is a big jump between the Oak Ridge homogeneous and the Pennsylvania Power & Light homogeneous in size.

Chairman ANDERSON. That is why I would call the Oak Ridge a pilot plant.

Mr. CISLER. Then we might call it a pilot plant, sir. However, one certainly is leading up to the other. I think we know full well in connection with their breeder development how important has been EBR–1 to what we have been able to do, and I certainly want to state publicly the very wonderful cooperation that we have had from the Argonne National Laboratory, so ably led by Dr. Zinn, in connection with this development.

Chairman ANDERSON. To go back to the first page, if I may, because I may get called out again, you say:

> As a member of Power Reactor Development Co., the Detroit Edison Co. has but one vote in the conduct of its business.

How many votes are there?

Mr. CISLER. Senator Anderson, there are 26 members of the Power Reactor Development Co. at the present time.

Chairman ANDERSON. And they each have one vote?

Mr. CISLER. Each has a single vote; yes sir.

Chairman ANDERSON. So that you are not able to control the situation; you have only one-twenty-sixth of it?

Mr. CISLER. Yes, sir.

Chairman ANDERSON. And if the other 25 decided not to go ahead, even though Detroit Edison had a large amount of money, you could not go ahead, could you?

Mr. CISLER. Not on that basis, no. We would certainly endeavor to do everything possible to go ahead.

Chairman ANDERSON. Do you make your decisions on what I might call strictly a democratic method, one vote for one firm?

Mr. CISLER. Yes. I think you would be interested, Senator Anderson, in the way the Power Reactor Development Co. is organized.

It has a board of trustees and a chairman of the board who is president of the Power Reactor Development Co. In addition to a trustee from each of the contributing members, we have some outside individual trustees, so to speak, because of their particular knowledge and experience.

Dr. Robert Bacher, who was the first technical member of the first Commission, is a trustee. Another is Dr. Theodore B. Wright, vice president of research at Cornell University. Still a third is Dean Stason, dean of law at the University of Michigan. Still a fourth one is Dr. Lawrence Hafstead, who was formerly director of Reactor Development.

Chairman ANDERSON. Does he have a vote?

Mr. CISLER. He has avote.

Chairman ANDERSON. Whose vote does he cast? He is not one of the 26 companies.

Mr. CISLER. No; he is only an individual.

Chairman ANDERSON. Do you have other voters besides the people who have stock then in it?

Mr. CISLER. There is no stock, sir.

Chairman ANDERSON. You said you were a member and had one vote. Are there 26 members and 26 votes?

Mr. CISLER. Yes, there are 26 companies.

Chairman ANDERSON. They each have a vote. That is 26. Where does Dr. Hafstad come in. Is he above that?

Mr. CISLER. Yes, he is a trustee.

Chairman ANDERSON. So you would have at least 27.

Mr. CISLER. Yes.

Chairman ANDERSON. And the Cornell man makes 28. How many do you have in all.

Mr. CISLER. We have Dr. Bacher. We have Mr. Edward Love. We have Mr. Hickson. We have 31.

Chairman ANDERSON. In your business experience is that a little cumbersome way to operate without a controlling interest anywhere in it?

Mr. CISLER. We have also an executive committee made up of trustees of the Reactor Development Co. and the executive committee is the active 18 group.

Chairman ANDERSON. How many members are there in that?

Mr. CISLER. There are eight. They are made up of the officers, the chairman of the financial committee, and the chairman of the technical committee.

Chairman ANDERSON. Let us go back to page 3. I wanted to check the 14 plants as you went along.

Mr. CISLER. Shall I resume?

Chairman ANDERSON. Yes.

Mr. CISLER. Some of these projects are being carried out by the Commission as part of its 5-year reactor development program, inaugurated in 1954. Others are being done by industry as a part of the Commission's power demonstration reactor program, while still others are being done by private industries strictly on their own, as commercial licensees under section 103 of the act. To the best of my knowledge, all of the types of reactors now considered likely to be capable of producing power on a competitive basis are included in these projects. Further, I am told by those associated with a considerable number of these projects that as much progress is being made as can reasonably be expected. Certainly, that is the situation with respect to the fast neutron breeder reactor project of Power Reactor Development Co. To be sure, progress has not been as rapid as we wish, but scientific advancement seldom has been accomplished overnight. Research and development work must be done in a planned and methodical manner along rational lines. There is no easy road to success, an actual accomplishment cannot be legislated.

The Detroit Edison Co. first became interested in atomic energy in 1945, immediately after the discovery of nuclear fission was given to the world at large. Edison, together with the Dow Chemical Co., formally undertook studies to determine the feasibility of utilizing atomic materials for commercial purposes early in 1951 as one of the first industrial groups authorized to engage in this work.

The selection of the breeder reactor as the type most likely to be capable of producing power on a commercially justifiable basis resulted from that study. It was fully recognized at the time that the technology of breeder reactors was less advanced than that of other types and that an exceedingly difficult research and development program was to be faced. It was believed, however, that more would be gained by directing our efforts to this long-range undertaking which seemed to have the greatest merit, rather than to somewhat less complicated types of reactors whose development potentialities appeared to be somewhat limited.

I need not recount the program that has been undertaken in assembling the groups now known as Atomic Power Development Associates, Inc., and Power Reactor Development Co., but I have attached lists of the member companies of those two organizations as exhibit I. The membership of these 2 organizations comprises 54 companies located in 18 States. Their support of this atomic power effort has been marvelous indeed. They are as follows:

Atomic Power Development Associates, Inc.
Alabama Power Co.
Atlantic City Electric Co.
Baltimore Gas & Electric Co.
Boston Edison Co.
Central Hudson Gas & Electric Corp.
Cincinnati Gas & Electric Co.
Cleveland Electric Illuminating Co.
Connecticut Light & Power Co.
Consolidated Edison Company of New York, Inc.
Consumers Power Co.
Detroit Edison Co.
General Public Utilities Corp.

Georgia Power Co.
Gulf Power Co.
Hartford Electric Light Co.
Indianapolis Power & Light Co.
Jersey Central Power & Light Co.
Long Island Lighting Co.
Metropolitan Edison Co.
Mississippi Power Co.
NEGEA Service Corp.
New England Power Co.
New Jersey Power & Light Co.
New York State Electric & Gas Corp.
Niagara Mohawk Power Corp.
Pennsylvania Electric Corp.
Philadelphia Electric Co.
Potomac Electric Power Co.
Public Service Electric & Gas Co.
Rochester Gas & Electric Corp.
Toledo Edison Co.
Wisconsin Electric Power Co.
Wisconsin Power & Light Co.
Allis-Chalmers Manufacturing Co.
Babcock & Wilcox Co.
Bendix Aviation Corp.
Commonwealth Associates, Inc.
Ford Motor Co.
General Motors Corp.
Jackson & Moreland, Inc.
Leeds & Northrup Co.
Pittsburgh Consolidation Coal Co.
Southern Services, Inc.
United Engineers & Constructors Inc.
Vitro Corporation of America:
Power Reactor Development Co.

Companies which have signified their intentions of becoming members, and to make necessary contributions:

Alabama Power Co.
Allis-Chalmers Manufacturing Co.
Babcock & Wilcox Co.
Burroughs Corp.
Central Hudson Gas & Electric Corp.
Chrysler Corp.
Cincinnati Gas & Electric Co.
Columbus & Southern Ohio Electric Co.
Combustion Engineering, Inc.
Consumers Power Co.
Delaware Power & Light Co.
Detroit Edison Co.
Fruehauf Trailer Co.
Georgia Power Co.
Gulf Power Co.
Holley Carburetor Co.
Iowa-Illinois Gas & Electric Co.

Long Island Lighting Co.
Mississippi Power Co.
Philadelphia Electric Co.
Potomac Electric Power Co.
Rochester Gas & Electric Corp.
Southern Services, Inc.
Toledo Edison Co.
Westinghouse Electric Corp.
Wisconsin Electric Power Co.

Both organizations have been designed to permit widespread participation by those who are interested, and to draw upon the many resources of talent of our industries and educational institutions. We have never limited our membership strictly to private industry. You may be interested to know that the Detroit Public Lighting Commission, which has no authority under the city charter to engage directly in research work, has assigned an engineer to our project so that it may gain experience in this field.

I can honestly say that since early 1952, when we began our active efforts to develop a breeder reactor, we have looked forward to the time when we might engage in an actual reactor project. In 1954, when the Commission first discussed the need for projects which would assure the United States leadership in atomic power development, we reviewed the technical status of our study project with great care. We concluded that the fundamental aspects of our work had advanced to the point where a construction project which would provide much needed experience and know-how might be safely undertaken. We realized, however, that the revenue which might be obtained from the operation of such a reactor would not repay its cost. These matters were discussed at length with the most competent authorities available: Dr. Lawrence R. Hafstad, Dr. John R. Dunning, Gen. Kenneth D. Nichols, Dr. Walter H. Zinn, Dr. Hans A Bethe, and others All agreed that the proposed reactor could be built and should operate as intended.

COMMISSION ASSISTANCE UNDER POWER DEMONSTRATION REACTOR PROGRAM

There were a number of areas requiring essential additional research and development work which, under the present circumstances, could be done expeditiously only in Atomic Energy Commission facilities. The work includes:

1. Irradiation tests of materials to be used in the reactor fuel and blanket elements;
2. Reprocessing of irradiated fuel elements, and
3. A critical assembly test of the proposed reactor core.

The Commission announced its power demonstration reactor program on January 10, 1955, a program designed to facilitate the undertaking of power reactor projects by industry. As a part of that program, and as an incentive to industry, the Commission offered, among other things, to do essential research and development work in Commission facilities, to allow the use of Commission facilities for the processing of irradiated fuel elements, and to waive rental charges on special nuclear materials for a period of time.

BREEDER REACTOR PROPOSAL UNDER POWER DEMONSTRATION REACTOR PROGRAM

As we reviewed our situation, we concluded that with Commission assistance in the areas indicated, it would be possible to initiate an actual construction project immediately rather than to wait the 2 to 5 years which otherwise would have been necessary. A number of those who had participated in the Atomic Power Development Associates' research and development work agreed that we should undertake this project. Our proposal, exhibit II, was submitted on March 30, 1955. We were advised by the Commission on August 8, 1955, that the proposal was approved as a basis of negotiation.

(Exhibit II follows:)

UNITED STATES ATOMIC ENERGY COMMISSION,
Washington, D. C.

GENTLEMEN: In furtherance of our letter of July 12, 1954, this proposal to design, construct, own and operate a fast neutron breeder reactor is submitted for your consideration in response to your January 10, 1955, announcement of a power demonstration reactor program. It is submitted on behalf of the Central Hudson Gas & Electric Corp., the Cincinnati Gas & Electric Co., Consumers Power Co., Delaware Power & Light Co., the Detroit Edison Co., Long Island Lighting Co., Philadelphia Electric Co., Rochester Gas & Electric Corp., the Toledo Edison Co., and others who have or may hereafter signify their intention to join this project. All but one of those named have been engaged in an intense effort to develop a breeder reactor that can be capable of producing steam for generation of electric energy on a commercially competitive basis.

The proposed reactor is described in some detail in the classified (confidential) document entitled "Description of Proposed Developmental Fast Neutron Breeder Reactor," dated March 25, 1955, which is submitted as an appendix hereto. A photograph of a model of the reactor-electric plant is attached to this letter. The design adopted is chiefly the result of the work of engineers and scientists assembled for the Atomic Power Development Associates study and research project. They reviewed information available from various sources, including your Commission Laboratories and personnel, and especially Argonne National Laboratory. They also sought out new information, and developed many new ideas which have been incorporated in the design. The results also reflect the views of private contractors and investigators, consultants, and others engaged in engineering and scientific activities.

The reactor will be liquid sodium-cooled, will utilize enriched uranium as fuel, and will be designed to produce heat sufficient for the generation of 100,000 kilowatts of electric power. Fuel elements will be made up of assemblies of clad uranium alloy pins. Blanket elements will be assemblies of depleted uranium rods.

We are prepared to meet with you at such time as you may wish, looking toward reaching a mutually agreeable understanding with respect to the following:

(*a*) A license to locate, construct, own, and operate a reactor to demonstrate its practical value; and

(*b*) A license to possess special nuclear material; and

(*c*) A sufficient supply of fuel and blanket materials, and

(*d*) The processing of irradicated fuel and blanket elements; and

(*e*) The payment by the Commission for special nuclear material produced by the proposed reactor; and

(*f*) The performance of certain research and development work in Commission facilities; and

(*g*) The matter of technical and economic data resulting from the reactor development.

If the foregoing and certain other problems can be satisfactorily resolved, we shall undertake to organize a nonprofit corporation (*a*) to design, finance, and construct a fast neutron breeder reactor; (*b*) to own and operate the reactor; and (*c*) to apply for and hold licenses from the Commission for such construction, ownership, and operation and the possession and use of special

nuclear and source materials. This corporation would be dedicated to research and development in the use of nuclear fuels, and results would be made available to you and to others as directed by you.

It is our judgment that the successful completion of this fast breeder reactor plant is now a matter of straightforward engineering development, design, and construction and that detail design of the reactor is possible within the limits of the proposed construction schedule. Furthermore, the continuing study of the design may result in certain advantageous improvements.

The control and safety aspects of the reactor have been analyzed at length. These analyses demonstrate clearly, in our opinion, that the reactor will be controllable and safe beyond any credible doubt. Moreover, it will be housed in a gas-tight cylindrical steel structure designed to contain the products of a possible reactor accident.

Our present plans call for the location of the reactor in the service area of the Detroit Edison Co. on a 1,200-acre site approximately 3½ miles southeast of the business district of Monroe, Mich. Practically all of the ground area within a radius of 1 mile would be included in the plant site area owned by the company. There are few residences within a 2-mile radius. We are also considering other sites within the service area of the Detroit Edison Co.

We believe that the reactor can be constructed and capable of producing steam for generation of electric power within approximately 4½ years after your acceptance of this proposal. This time would include a period of more than 1 year of preliminary operation during which significant amounts of steam might be produced.

In order to meet the time schedule desired, research and development work of the following nature, which can best be done in your Comission facilities, as offered in the Commission announcement of January 10, 1955, would be needed:

1. Critical experiment.
2. Safety test.
3. Radiation damage tests.
4. Fuel reprocessing development.

The extent to which your Commission may desire to participate in other research is a subject we will be pleased to discuss. We would expect to work closely with Argonne which has been most helpful.

We estimate that the total cost of the reactor, exclusive of electric generating facilities, would range up to $45 million, distributed approximately as follows:

Plant site and improvements, $1,700,000.

Research and detvelopment work, $9 million.

Engineering, design, and construction of reactor plant, $29,100,000.

Preliminary operation, working capital, business and miscellaneous expense prior to firm operation, $5,200,000.

Total cost of reactor, $45 million.

Coincident with the construction of the reactor, the Detroit Edison Co., at its own cost, estimated as $9 million, will proceed with the construction of electric generating facilities having a capacity of not less than 100,000 kilowatts. Thus, the total cost of the entire project would be approximately $54 million.

We now have reasonable assurance that more than two-thirds of the total estimated cost of the entire project will be available when the proposed licensee is organized and its finance plans made final. We believe it will be possible to have the balance provided by agreements of others, some of which have signified their intention to participate in this project. Of necessity the complete financing is therefore dependent upon the joinder of others.

It would be important to us that the licensee corporatiton be reasonably sure of its ability to obtain adequate insurance. We understand that he Commission has joined with representatives of the insurance industry in a study of this important matter.

In making this proposal we assume and regard as essential the following: (1) that neither the licensee corporation will qualify as deductible for Federal income-tax purposes.

We would, of course, expect that the construction, ownership, and operation of the reactor will be subject to complete regulation by the Atomic Energy Commission.

We will be most pleased to discuss this proposal with you at any time that may suit your convenience. Our desire is to go forward with this project as rapidly as possible when we have reached agreement with you.

Very truly yours,

THE DETROIT EDISON CO.,
By WALKER L. CISLER, *President.*

JULY 12, 1954.

Gen. K. D. NICHOLS,
General Manager, Atomic Energy Commission,
Washington, D. C.

DEAR GENERAL NICHOLS: On behalf of ourselves and the others in our atomic power development project, I wish to express our special appreciation of the information which we have received recently from Dr. Lawrence R. Hafstad. He has made three presentations to our group, one to a meeting of the technical and engineering committtee, one to a meeting of the executive committee, and lastly, earlier this month to a meeting of the full management committee of the project, in New York City, attended by chief executives and top technical assistants of all our companies.

Following Dr. Hafstad's presentation in New York, the management committee directed the executive committee to arrange for a study and report, as soon as possible, looking toward the submission to the Commission, by interested members of the group, of a proposal for construction of a suitable breeder reactor, consistent with the objectives outlined by Dr. Hafstad.

It is impossible in this short time to set forth any proposition in detail. It is the intention of my company, however, and of others in the group, to prepare and submit a definite proposal. We believe that our study of the technology has proceeded to the stage where it will be possible to complete the basis for a proposal in the latter part of this year. This belief has been strengthened by a recent discussion with Dr. Zinn.

I am writing now to let you know that we intend to cooperate to the full extent of our ability in the effort to advance the industrial utilization of nuclear energy, and to provide production, along the lines Dr. Hafstad discussed with us. We look forward to making a proposal on the basis of private financing in character and extent which seems appropriate for private investment in accord with Government policy.

In working to crystallize a proposal we are confident that the cooperation which we have enjoyed with members of your staff will continue. We expect to be in touch with them further during the summer.

Sincerely,

WALKER CISLER.

Mr. CISLER. I believe it necessary to speak briefly about certain matters included in the proposal which recently have been the subject of public discussion.

On public liability protection, we stated that the licensee corporation would need to be "reasonably sure of its ability to obtain adequate insurance." We did not specify or suggest Government indemnity in the proposal, but rather pointed out a problem common to all power reactor projects, regardless of whether ownership was private or governmental. We testified with respect to this situation before this committee on May 16.

On the application of the Public Utility Holding Company Act, we also stated in the proposal that we assume and regard an essential that "neither the licensee corporation, nor any member thereof or contributor thereto will become subject to the Public Utility Holding Company Act by reason of participating in this project." I seriously doubt whether anyone who has taken the time to study this project—how it is being conducted and the reasons therefor—would claim that the existing Public Utility Holding Company Act was intended to apply to our present situation. An examination of the legislative history of that act will reveal no grounds to the contrary. The Chairman of the Securities and Exchange Commission has testified, however that the law does apply.

The legal counsels of the companies participating in Power Reactor Development Co. have advised that an amendment of the law is the best way to obtain adequate assurance that their status would not be

changed. Here, too, I am sure that any one studying the testimony in behalf of those interested in this project, or who may be interested in similar projects, must agree that no criticism of the present law or violence to it has been suggested.

No company now subject to the Public Utility Holding Company Act would be removed from the jurisdiction of the Securities and Exchange Commission.

INCOME TAX CONSIDERATION

The final reservation, and possibly the most difficult one, has to do with taxes. We stated that we assume and regard as essential—

that the contributions of the members of the licensee corporation will qualify as deductible for Federal income tax purposes.

We have not sought a change in the law on this matter. Rather we have requested an Internal Revenue Service ruling which will clarify and make certain the situation, just as any prudent businessman would do. If the Detroit Edison Co. itself, or any other single company, were to do research and development work relating to its business, costing, one, five, or even ten million dollars, there would be no problem whatever as to its qualification as a business expense. Moreover, a single company might employ a professional organization to do the research work and the expense would be recognized as a deductible business expense.

Thus, when a group of companies agrees to undertake jointly a research and development project as costly as the one in question, whether it be under the name of Power Reactor Development Co., or in some other manner, it is understandable that the tax situation must be clarified. Otherwise it would be impossible to formulate a budget which would give any control of expense.

Our objective is to develop and perfect an atomic power reactor suitable for use in today's large power systems. To carry out the research effort, we must build and test a developmental breeder reactor, having a capacity of at least 100,000 kilowatts, and we expect as much as 150,000 kilowatts, which will cost about $40 million. The scientific and engineering matters involved cannot be demonstrated without building and testing a full scale installation.

It is important that we all realize that the developmental reactor with which we are dealing is not permanent or final in any sense. It is as the name implies only "developmental" and temporary. It is a prototype of something to come in the future. When we get it built, it may not even work , but we believe this is a very remote possibility. Experience gained in its operation will provide the design of second and third reactors, which we have already commenced to think about, based on research work performed to date. Because of its temporary nature, no one would thing of putting such a novel and untested reactor in a plant account. This is in contrast with what others are doing with reference to reactors of which more is known. Our reactor at this stage should not be compared with reactors of a more conventional type. Since breeding has not been demonstrated on a large scale, we are dealing with new science and with a great many extremely difficult technical problems.

Chairman ANDERSON. Mr. Cisler, I am not anxious to stop you, but this hearing is primarily on what your reactions are to the Gore bill and

the proposal for some reactors to be built by them. At the previous hearing we discussed this tax question and the problem of the Public Utility Holding Company Act. I am perfectly happy for you to go ahead and present to Senator Gore and to me, but we were primarily hopeful of the reactions to the Gore and Hollifield bills. You may proceed as you wish on it.

Mr. CISLER. Senator Anderson, I felt because of what has been said publicly that there was a misunderstanding on the part of some as to why we sought clarification on these matters of the Holding Company Act and insurance and the matter of taxes, and I have endeavored to develop here for you the reasoning that we believe is valid for the position that we have taken on these matters. I think it is particularly true on the matter of taxes because certainly the expense of doing research and development work is an expense deductible from income. It is an expense which occurs before you reach the point of statutory taxable income. That income belongs to the owner of the business and the Government takes from that such percentage as it needs to conduct its own business. I feel that it is important and because of questions which have been asked and discussions which have been held that we ought to make it very clear to this committee what our position in connection with taxes is.

Chairman ANDERSON. I still do not see exactly what relationship that has to the proposal of the Gore bill for the building of several other plants. But if you do, I do not wish to stop you. We are in a strange situation today. We are not able to find members from the House side here. We are in a steady routine of rollcalls. Under the circumstances I will have to adjourn until we can come back from this rollcall.

(Short recess.)

Mr. CISLER. Mr. Chairman, about 4 years will be required to complete the construction of the plant and the extensive preliminary testing before the reactor can be brought up to power. We believe as much as 10, or even 15, years of operation may be required for experimentation and modification, and to gain the experience and know-how the reactor will provide. More than 3 years of operation will be required to build up the plutonium concentration in the blanket elements to the point where the reactor can be said to be operating in an essentially balanced manner.

Because of the expected very rapid advancements in nuclear reactor technology, it is probable that by the time these research activities are completed, the reactor will be obsolete. In any event, its value as a production installation is likely to be exceedingly low. The point important to us, therefore, is that the contributions of the member companies, for which a tax ruling has been asked, will go to build an expendable research facility and that the contributors, in accordance with the charter of Power Reactor Development Co., cannot under any circumstances recover those contributions. The only real benefits the contributors can receive is the experience and know-how which will permit them to utilize atomic power for their own purposes. And these same benefits will be available to others at the direction of the Commission.

The argument has been made that allowing a deduction for amounts paid for research, development, and construction of a power reactor is a Government subsidy. I respectfully submit that this is specious

reasoning from a false premise. "Subsidy" and "allowance" for income tax deduction are not synonymous by the wildest stretch of imagination.

The false premise is that all income belongs to the Government. Unfortunately, that may be true in Iron Curtain countries but in the free world, income belongs to the one who produces it. The Government's interest is only to obtain that portion of income necessary to support the Government, and after deductions, and at tax rates established by Congress. When the Government allows a deduction, it does not make a gift to the taxpayer; it simply refrains as Congress provides that it should, from taking tax toll on that portion of the taxpayer's own income, not the Government's income but the taxpayer's, which is represented by the deduction allowed. It cannot be a subsidy because a subsidy requires use of the Government's money to aid a citizen and the deduction is not the Government's money.

The false and specious reasoning is as follows:

1. It assumes a tax on gross income. The income tax is on net income, not gross. The Government has an interest only in net and the Government's claim begins only after net is determined. Congress determines what deductions are allowable and research and development expense is one of the items Congress allows.

2. It ignores the fact that the same argument can be advanced as to every deduction including the two greatest ones for any business—labor and materials. No one would think of calling deductions of labor and material expense a subsidy. The fact that the argument is not applied to labor and materials is proof of its falseness as applied in this situation, because the amounts in question actually are for labor and materials. The only difference is that the deductions are to be expended in the aid of an ultimate goal—namely, the future production of electric energy by the use of atomic fuels rather than by present methods.

3. It is erroneously assumed that every dollar contributed to the power reactor program would, if not allowed as a deduction, end up as an extra dollar of net income of the contributor company. This is not true. The money in question might be devoted to research on the more economic use of coal or some other research project, or for advertising, compensation, or any of numerous other deductible uses. The electric industry has always engaged in research and development work to provide more efficient and low-cost generation.

4. It is erroneously assumed that every dollar disallowed as a deduction would not only end up as net income, but, after tax, would then be paid out as dividends and be again subject to tax in the hands of the recipient. I have already shown the falsity of the subsidy argument as to the corporate income. The subsidy argument as to dividends is even more absurd because what may be paid as dividends is subject to all the uncertainties of State and Federal public utility regulation, Securities and Exchange Commission requirements, capital requirements of the corporation, judgment of its board of directors, and economic conditions.

5. Finally, there is failure to recognize that the Congress, by regularly allowing deductions for research and development expense, has already indicated that public policy favors this type of deduction. Congress realizes that today's taxpayer becomes tomorrow's bigger taxpayer by being encouraged to develop greater efficiency in existing

lines of endeavor and to create new sources of income. Atomic energy offers boundless opportunities for new sources of income. Development in this field, which is new and untried, has to be encouraged, not stifled, by allowing it the same research expense deductions that are allowed in every other field.

Permit me at this time to leave with you the thought that "subsidy" is a word with ugly connotations and, as I believe I have demonstrated, is unfairly and illogically applied to the research deduction that is here sought. As we have noted, Congress already has indicated that it considers this type of deduction equitable and hence allowable. The Congress knows that deductions are not subsidies but are the means by which the income-tax law is made fair and equitable in its application.

Ownership of Conventional Steam Turbine-Generation Facilities

Now, to go on to another point, there has been negative comment concerning the fact that the reactor part of the plant will be owned by a new nonprofit corporation, Power Reactor Development Co., and that the steam-turbine generator facilities will be owned by the Detroit Edison Co. Even a casual review will show that exactly the same plan is being used for the pressurized water reactor project at Shippingport, Pa., and the sodium reactor experiment at Santa Susana, Calif. The only difference is that in our case the reactor is being built and paid for entirely by private investors' funds, rather than by the Government.

It is well understood that the steam-turbine generator part of an atomic powerplant is composed of essentially conventional equipment. In view of this, it is not appropriate to include this part of the plant with the reactor which is strictly of a developmental nature and particularly since the cost of the reactor is to be shared by many companies. The reactor is to be built in an area served by Detroit Edison and that company has offered to provide the turbine-generator and associated facilities at its own expense. This will relieve the reactor project of the need for financing the turbine-generator part of the plant, which will cost about $14 million. For accounting purposes Detroit Edison plans to treat the turbine-generator facilities as a normal power system investment.

The contract for the purchase of the steam by the Detroit Edison Co., is now being negotiated. The basic principle being used is that the Detroit Edison Co. will pay, as closely as can be determined, exactly the same price for the steam produced by the reactor as it would cost Edison itself to produce steam capable of producing an equal amount of power in a modern plant which it might build today. The rate will be one negotiated "at arm's length" and will include the proper amounts for capital cost. It is now being determined by some of the most competent people in the electric power business and I am sure it will be fair and justifiable under all circumstances. It is unreasonable to assume that other utility and industrial members of the reactor company would permit the Detroit Edison Co. to purchase the steam at an unrealistic cost.

This contract, when completed, will become a part of the basic agreement between the Atomic Energy Commission and the Power Reactor Development Co. This agreement establishes the conditions under

which the project is a part of the Commission's power demonstration reactor program. The Commission also may be depended upon to appraise the adequacy of the price paid by Edison for steam because under the proposed agreement, under certain conditions, the Commission has the right to take the project over, complete it and operate it.

PROGRESS OF POWER REACTOR DEVELOPMENT COMPANY PROJECT

Let us now consider the matter of progress in our project. Surely anyone familiar with nuclear reactor development is aware that projects of this kind are initially based upon thoughts, ideas, and conceptual designs. There is no completed blueprint of any advanced project and therefore a tremendous amount of preparation and background work must be performed before it is possible or necessary to undertake actual field construction.

An excellent example of this is the previously mentioned PWR installation at Shippingport. It is well known that PWR is an adaptation of a reactor originally developed in part by Westinghouse Electric Corp. for an aircraft carrier and that more than $9 million has been spent in research and development prior to the time PWR was inaugurated.

The first public announcement of PWR was in late October 1953. Shortly thereafter, Adm. Hyman Rickover, who quite rightly enjoys the reputation of being one of the most forceful and effective men in the world in the matter of getting things done, was assigned to direct the Atomic Energy Commission's part of the project. In March 1954, the Commission accepted the proposal of Duquesne Light Co. to build the steam turbine generator part of the plant in the Pittsburgh area. Ground-breaking ceremonies were held on Labor Day of that year and active field construction was started in the spring of 1955. It is reported that the plant will go into initial operation during 1957.

I am sure that all who know the problems that are involved will join in congratulating those associated with PWR for an excellent and outstanding performance. I would like to add, too, that if all goes as we now anticipate, ground-breaking ceremonies will be held for our breeder reactor project this coming August 8, exactly 1 year after we received tentative approval of our proposal.

Beginning early in 1955, the research and development activities of Atomic Power Development Associates, Inc. were accelerated. A 3-year program, costing roughly $4 million in 1955 and about $5 million in both 1956 and 1957 was planned and is now in full swing. This, together with the research work which the Commission is considering, is expected to provide practically all of the information for the complete design of the reactor part of the plant.

I have here again today the two models which I displayed last week because they are so truly representative of progress. I would like to repeat my statement concerning them. The smaller one is of the entire plant including the steam turbine generator. The larger one is the heart of the plant the breeder reactor itself. We use these models continuously in our discussion of the plant and its design.

These models represent the accomplishment of intensive research and development work that has been underway since late 1950. As of today more than 85 skilled engineers scientists mathematicians and others are continuing this work in Detroit. Many others are simi-

larly engaged by contractors working for us. Today more than $8 million has been spent in this effort.

In order to build these models we had to develop the complete conceptual design of the entire plant including all of the major components of the reactor and its related facilities. There was no blueprint to which we could go. Nothing like it has ever been designed or built before. We had to start from the ground up. It has been a long difficult and sometimes tedious task.

It is important to say here, too, that the conceptual design has been discussed and studied in detail by the most competent authorities in the business. All are agreed that the design is fundamentally sound and that the reactor should work as intended if proper attention is given to the detailed design.

We are now engaged in studying and evaluating each component in detail to assure insofar as is possible that it will function as intended. Only through this process can we be reasonably certain that the reactor will perform satisfactorily.

These same conditions must be faced by anyone undertaking a project of this kind. They account for the long time that has been required to complete earlier reactor projects. These conditions will affect any project of this kind private or governmental however and whenever undertaken.

We believe we are making excellent progress in this work. We are completing experiments pertaining to the reaction between sodium and water should they be accidentally mixed and the action which results when sodium escapes into the atmosphere. These are but two of many important safety considerations. We have recently completed for test purposes the installation of a prototype steam generator, or boiler, such as we intend to use in the plant.

An important part of the Atomic Power Development Associates' program is a full-scale test facility, which comprises actual major components. These components, listed in exhibit III, will be tested under simulated full load operating conditions, but without the presence of radioactive materials. As indicated by exhibit III, Atomic Power Development Associates has now committeed more than $3 million to this test facility and the full cost of the job, including manpower during the testing period, is expected to exceed $6 million. After testing, it is expected that these components, if acceptable, will be used in the reactor itself.

Last week I stated that preliminary site preparation is now in progress. Power Reactor Development Co. has selected Commonwealth Associates, Inc., as its architect-engineer and United Engineers & Constructors, Inc., as its construction engineer, and they already have begun their duties. The Detroit Edison Co. has placed an order with the Allis-Chalmers Manufacturing Co. for the turbine-generator, with a capability of 150,000 kilowatts to be delivered in 1959, and also has retained United Engineers & Constructors, Inc., as construction engineer.

As we review the situation, we are unable to find where further progress could have been made in our project unless we had had preemptive authority in the use of governmental and private laboratory faciilties, which to us was not warranted.

Faster progress than we and others have made in the development of atomic power is desirable but it cannot be accomplished by the simple and costly expedient of a "crash program."

COOPERATION WITH GOVERNMENT AUTHORITIES

A word of commendation and appreciation concerning the excellent cooperation and healthy relationships we have had with the Commission's national laboratories and with Federal, State, and local authorities is appropriate.

The work that Argonne National Laboratory has done on the fast breeder type of reactor has been of utmost importance to us. It designed, built, and operated experimental breeder reactor-1 which demonstrated the feasibility of breeding, and has performed mockup tests, the results of which are useful in connection with our full-scale design. Argonne's help in design, physics, metallurgy, and reprocessing has been invaluable to us.

The Oak Ridge National Laboratories have offered us assistance whenever possible. They have provided us with valuable shielding and reprocessing information. Ten of our scientific staff have been trained at Oak Ridge School of Reactor Technology.

The other national laboratories such as Los Alamos and Ames have been willing to exchange information of mutual interest. These friendly relationships provide an atmosphere which has effectively promoted technological development.

We have had the finest cooperation, too, from State and local authorities. The Michigan Public Service Commission has shown a keen interest in all of the matters involved in nuclear power since the beginning of our project. Other agencies such as the departments of insurance, health, public safety, labor, and conservation, have been helpful in many ways. Local authorities in the area of the plant site have done everything possible to permit our project to go ahead.

To us, this surely represents as effective cooperation between Government and industry as anyone might desire or contemplate.

APPLICATION OF SECTION 44 OF THE ATOMIC ENERGY ACT OF 1954

Now I would like to comment briefly on certain other implications of S. 2725 as I see them.

If the bill were intended to encourage further research and development in bringing about an early utilization of atomic energy in the generation of electric power, there could be no valid objection to such research and development work. However, that is only half of the story. I attribute no improper or selfish motives to anyone, but the consequences of such research and development work, whether it was so intended or not, would place the public power projects in direct competition with private power in six different geographical sections of the United States. There is no escape from these consequences because of the operation of section 44 of the Atomic Energy Act of 1954, which provides as follows:

> If the energy is produced at production facilities of the Commission or is produced in experimental utilization facilities of the Commission, such energy may be used by the Commission, or transferred to other governmental agencies, or sold to publicly, cooperatively or privately owned utilities or users at reasonable and nondiscriminatory prices * * * in contracting for the disposal of such energy, the Commission shall give preference and priority to public bodies and cooperatives or to privately owned utilities providing electric utility services to high-cost areas are not being served by public bodies or cooperatives.

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This would require that the Atomic Energy Commission sell to the public groups as a statutory preference customer all electric energy produced.

I do not wish to prolong these hearings by a discussion of the preference clause, but the inevitable effect of Senate bill 2725 would be to create new discretionary situations among the citizens of certain States, or perhaps between the citizens of one State and those of another State, merely because of the fact that some areas might be served by a public power group, and other areas might be served by a private company. This is grossly unfair.

I believe that the early and full utilization of atomic energy in the generation of economical electrical energy should not be frustrated by any preemptive right vested in anyone. The application of section 44 of the Atomic Energy Act of 1954 to any project authorized by S. 2725 would restrict the benefit to the public power groups. The interest of all the people should not be thwarted or prejudiced by political consideration of those who believe in public power as opposed to those who believe that private industry holds the key to the future success of our country.

DELAYS WOULD RESULT

There is another important aspect of this situation to which I must refer. The number of persons qualified by ability and training to engage in research and developmental work in the field of atomic energy is limited. In addition, the materials and fabrication facilities required for the manufacture of power reactors are also limited. The addition of new projects under Government sponsorship must of necessity dilute the effort which can be applied to the projects already underway. Of greater importance perhaps is the fact that in times of shortage, Government requirements inevitably take precedence. This, I can see that additional projects by the Atomic Energy Commission, as proposed by S. 2725, under congressional directive, would delay rather than accelerate atomic power development.

SUMMARY

In summary, let me repeat that I believe as strongly as anyone that atomic power development should be carried forward as rapidly as possible. I believe, however, that we should proceed in an orderly, rational manner with each step designed to provide a worthwhile and substantial advance in the art. We simply cannot afford to waste our resources or hinder our progress by a needless crash program. We cannot afford to inject senseless political situations into such an important and essential part of the industrial and economic development of our country.

Senate bill 2725 provides absolutely nothing that cannot be accomplished better under the existing law. It would serve no constructive purpose, it would be wasteful of the taxpayers' money, and it would contribute nothing helpful in the international situation.

Senator GORE. You just said, Mr. Cisler, that nothing could be accomplished by the terms of this bill which cannot be accomplished better by the present law. Is that a correct statement of your view?

Mr. CISLER. Yes, sir.

Senator GORE. Suppose that the Atomic Energy Commission wanted very much to see large-scale atomic reactors built using 6 particular

designs, using 6 different processes, but they were not able to obtain a proposal by private concerns to construct that 1 or that 6, which the Commission thinks would be particularly promising. How could that be better accomplished under the present law?

Mr. CISLER. I believe that if the Commission feels that a particular type of reactor is a desirable one to be carried out that the Commission would well do as they have in connection with the other projects, talk with those who are carrying on the studies and research work.

Senator GORE. I had in my hypothesis leaped over the discussion. The Commission is unable to obtain proposals from private concerns to construct reactors by the particular designs which they think are promising. How could that be accomplished under present law?

Mr. CISLER. I don't believe that they have been unable to obtain proposals because I think they have obtained proposals.

Senator GORE. That is not the question. You have made a statement for which I am trying to elicit from you support. If you do not wish to respond to a hypothetical question, it is all right. I don't wish to press you on the matter.

Mr. CISLER. I believe, Senator Gore, that the Commission now can under the present provisions of the Atomic Energy Act carry on all such research and development work and carry on cooperative efforts with industry as they have been doing. If there are types of reactors that seem desirable to develop, I know of nothing that makes it impossible for the Commission to proceed in an orderly manner.

Senator GORE. I don't wish to press you on the question. It is quite all right.

Mr. CISLER. I am trying to give an answer in what I have said.

Chairman ANDERSON. Senator Gore asked you what Senator Barkley used to call a "suppositious" statement. Just suppose that the Commission wanted to build a gas-cooled type and no American company is interested in that, even though the British are doing it and the Russians are doing it. Suppose the Commission voted unanimously to do it, they could not do it under the law. Are you opposed to them going ahead?

Mr. CISLER. No, indeed. I think our whole record in this is proof of the fact that we have gone all out to carry on research and development work and to actually go into the construction. As I said just a week or so ago, we propose to break ground for this breeder reactor project, and I have here with me photographs of work already underway.

Chairman ANDERSON. That is for a type you believe in.

Mr. CISLER. Yes.

Chairman ANDERSON. Supposing the Commission had one that you didn't believe in, and they could not persuade you or Consolidated or Commonwealth of Pennsylvania Power & Light to go ahead with it; what then? Do they just sit down?

Mr. CISLER. No. I think they could proceed on their own.

Chairman ANDERSON. Under what law?

Mr. CISLER. Under the present.

Chairman ANDERSON. They can build little research types. They took the Johnson amendment out of the act in 1954 which would permit them to build a large type plant.

Mr. CISLER. I think, Senator Anderson, on any of the types which have not yet been undertaken certainly there would be a very substan-

tial amount of research and development work in the laboratories that would be necessary before they would reach the point of actually building a big one.

Chairman ANDERSON. Precisely.

Mr. CISLER. That work would lead up to where it would be shown that it was desirable to go into a gas-cooled type.

Chairman ANDERSON. They might be able to do it under research and development proposals, to be sure. We are trying to suppose that they don't want to do this now. We tried to get to it the other day. I asked Dr. Zinn if there was a particular reactor concept that he felt had reached a stage of development and where something might be done, and he pointed out that the Government has had many years of experience in operating Hanford type reactors which are graphite, water-cooled, and these can be converted or their type can be converted to a power reactor by merely pressurizing the water-cooling channel. Nobody wants to do that.

We have had the experimental work. Hanford has been running, as you well know, for a long, long time. Nobody wants to try it. It may not be quite as promising. But it might turn out to be the most promising type of all. So if nobody wants to try it, and the Commission does not want to take a plunge, what we wonder is what is wrong with the Congress saying, "Give us one of these; we would like to try it on for size." That is the proposal of the Gore bill.

Secondly, we came along to another type. He said that we have had an enormous experience at Savannah River with a type of reactor which, if it were changed in design to be a pressurized heavy water reactor, rather than a nonpressurized one which it is now, gives as much promise as any heterogeneous-type reactor for economic power, especially when one takes into account that the American Government can produce heavy water at astonishingly low cost, or at least it astounds the other countries.

The witness that was testifying was Dr. Zinn, who designed the Savannah River reactor. I think perhaps his testimony ought to be taken with some seriousness. If he believes this and the Commission decides it is not going to build anything of this nature and the Congress says we would like to get that, too, and try that horse in this race, we don't quite understand what is so wrong with it.

Mr. CISLER. Senator Anderson, as Dr. Zinn well knows, I have the highest regard for his competence and ability. Much of the success that we have had in connection with our breeder reactor is the result of the work which Dr. Zinn and his associates have done at Argonne. I would certainly not in any way take issue with Dr. Zinn because he is far more qualified than I am personally in matters of nuclear energy.

Chairman ANDERSON. That is all I wanted to say to you. We are not trying to upset everything in America. We are not trying to get the Commission to stop the work that it has done. We are not trying to get it to cancel the promises made to do research work for various organizations and various companies. When we see a statement made that Russia is going to have a substantially larger amount of electrical energy available by 1960 than is contemplated by the program in this country, and when we think that may have some bearing on certain other races and may have some propaganda value, we

suggest that maybe it might not be too bad if this country tried a little of that.

I can give you some reassurance. You mentioned in your statement the insurance situation. We are pressing as hard on that as we can. We hope to introduce a bill tomorrow. We have had it ready for 2 or 3 days, but sometimes the more haste the less speed, and we have taken a little more time to check some questions that have arisen. This is the bill that the committee will propose. The Atomic Energy Commission has also proposed a bill which may be introduced. As a result of those 2 bills, we hope the insurance people and the electric energy industry will study the 2 bills and give us their opinions. If they want to be heard on them we hope to have a short hearing. I would not want to stretch it out more than a couple of days if it could be compressed into that short time. Thereafter the committee would try expeditiously to report a bill to the Congress which I would hope we would be able to persuade the leadership of both Houses on both sides of the aisle to move forward with and try to get it before the Congress.

Mr. CISLER. May I say, Senator Anderson, what your committee and you yourself have done has been wonderful in helping to bring about a better understanding of the insurance matter and the public liability protection. It is indeed grand to hear of the action to be taken.

Chairman ANDERSON. We are moving right along. On the Holding Company Act, we had a peculiar situation. The subcommittee of another committee, headed by Senator Pastore, held its hearings. He got testimony in favor of the bill from one Government agency, testimony against the bill by another Government agency. Naturally, when that happens it is confusing to the committee. He thought by some modifications in the bill, perhaps, he would be able to work out a situation where he had support from both Government agencies.

You are practical enough to know that it would be much easier to pass a bill which the Government supported in all of its branches than to try to pass a bill which 1 agency is for and 1 agency is against. I happen to have been wrestling for months now with a bill that attempts to define the rights of States to the control of the irrigation waters, both ground and underground, in these various States, and one of the perplexing problems is that Interior is in favor of the definition of these rights and renunciation of them, Agriculture is also in favor of it, and Justice is violently opposed to it. We have harmony on our committee, but it is a somewhat divided harmony. We are not quite able to bring ourselves together any more than the Government is able to bring itself together. That is the problem on the Holding Company Act.

If Senator Pastore, who is sincerely trying to work out something, succeeds in the next few days in bringing those positions together, he then expects to report the bill, and I am perfectly willing to tell you that he expects simultaneously to ask that the bill be re-referred to the Joint Committee on Atomic Energy because, as a matter of practice, an atomic-energy problem should properly come back to this committee.

But we in turn hope that we would be able to report it very expeditiously to the Senate and House and again try to get action upon it.

Mr. CISLER. That would be very helpful, sir.

Chairman ANDERSON. I can only say on the tax situation that I have tried to find the time when I could discuss that with Senator Byrd of the Finance Committee. I think that is probably where it ought to be discussed. He has been, as you know, busy with the Social Security Act, busy again with the roads bill. It will be brought to the attention of his committee as promptly as it can, and we hope something can be done there.

I do want to say this with reference to the preference clause. That is a matter which the committee will probably have to consider carefully when it gets into session. I am not sure in my own mind what ought to be done with it. I think the discussion we had the other day with Chairman Strauss was interesting. He was hoping that Senator Gore would have an open mind on this bill, and Senator Gore had equally high hopes that Chairman Strauss would have an open mind. On this matter of the preference clause we hope that everybody will try to preserve an open mind, but recognize that the preference clause is not something that was loosely and casually written into law. It goes back to the days of Theodore Roosevelt. It is pretty well established in American doctrine.

There is this difference. It was written in in connection with falling water which supposedly will continue to deliver electrical energy for a thousand years if we protect our timber and preserve our forests properly and our watersheds properly, whereas these plants that we are discussing might take a different tax situation, because they will not go on for a thousand years. They will probably be small plants, relatively speaking, compared to the final plants. They will only last for a few years at best because we hope much more modern and progressive plants will come in. They may be supplanted entirely by some type of thermonuclear energy 25 or 50 years from now. Certainly they are not going on for a thousand years.

So we will try to be as careful as we can when we come to a tax situation.

Mr. CISLER. Yes. In that connection, Senator Anderson, it is not that we are asking for a change in the tax law. We have asked for a ruling from the Internal Revenue Department. We have endeavored to give you the reasons why we have sought that ruling because of this being a research and development project.

Chairman ANDERSON. I do think, Mr. Cisler, that the problem may be complicated somewhat because of the unusual setup that you have. I have said that I don't think it should be. Certainly the new General Motors Research Building is not going to be an institution where the payroll is going to be charged to something other than expense. I don't think any Congressman would contend for one moment that the payroll of that General Motors Research Laboratory should not be charged to expense. If your setup is not one that permits you to do that in the purely research work you are doing in this project, then, of course, we ought to try to help you if you don't get the ruling you seek.

Mr. CISLER. Senator, I would like to take a moment to tell you that our purpose in bringing these two exhibits to you is to show you what we have done and what we are doing. This is a going project. Equipment is being built in the manufacturing plants. Equipment is being tested. People are working and working very earnestly. I could show you photographs not only of work which is underway in

research and test, but I can show you preparation of site, pile driving, and the like. So we are approaching this in very much the same way as we approach our conventional work. We are carrying on a great deal of new construction work. We are trying to bring this atomic-development work right in line so that we treat it as far as possible with all the experience and all of the know-how that has been gained over many years in this industry.

Chairman ANDERSON. I am just wondering, Mr. Cisler, what your reaction might be if the approach of the Gore bill—I am sure the Senator from Tennessee will realize that I am not trying to amend his bill but only trying to find out what you would think about a different approach—so that it was changed to follow the Shipping port approach. We talked about this 3 or 4 types of reactors that some people think of as possibilities. Dr. Zinn outlined, I think, 5 of them. Suppose we said here are 3 very likely prospects, 3 extremely good horses on which we would like to place a bet, and the Atomic Energy Commission did what it did in the Shipping port matter, in which it is going to pay for the reactor, set the schedules, and direct the work, Duquesne is providing the generating facilities and will operate the plant. Would that strike you as a better method of testing these three reactors and would it be objectionable?

Mr. CISLER. Senator Anderson, as I understand it, the Shipping port project was under the old law, the act of 1946, which did not permit private ownership of the facilities nor was there this preference clause in the old act. The new act does have this preference clause. I just ask myself the question, How would the power output coming from such a reactor be handled, because of section 44?

Chairman ANDERSON. I am trying to get reactors built. Suppose we avoid the discussion of the preference clause.

Mr. CISLER. For research and development work that would be very fine.

Chairman ANDERSON. Suppose they will generate power and sell it; certainly they are going to sell the power from Shippingport.

Mr. CISLER. The steam is going to be taken over by the Duquesne Light Co. in exactly the same way as Detroit Edison takes over the steam from this.

Chairman ANDERSON. I assume you are not opposed to taking steam. Suppose we set three plants up for producing steam. Do you think it would be wrong for some company to take that steam and turn power out of it?

Mr. CISLER. If they would wish to do so that would be perfectly satisfactory.

Chairman ANDERSON. Our difficulty, as you can well see, is that if we are going to get a test of these rather promising types that are being tested now by Britain and Russia, and are likely to be tested in other parts of the world, it appears to us—we may read the signs wrong—that the only way they will be tested is by the Congress directing it. They apparently will not get done on an optional basis. The only things that are going to get done are similar to the Nautilus plant or things that the Pennsylvania Power & Light Co. may do after the second reactor at Oak Ridge works for a while.

Mr. CISLER. I would feel, Senator Anderson, if there was equal opportunity for both the public and private systems to purchase that

steam that would be certainly equitable and satisfactory. There should be equal opportunity.

Chairman ANDERSON. I think that some of us who went through the difficulties of the West Milton plant know that the preference clause is not primarily designed to work in the New England States or places of that nature. There are problems in connection with it. I hope I am able to recognize that.

We will recess now for a short time while we attend a quorum call.

Mr. CISLER. Thank you for allowing us to come.

Chairman ANDERSON. Thank you, Mr. Cisler.

(Short recess.)

Chairman ANDERSON. Dr. Smyth, we are very happy to have you here again. We enjoyed having you when you were a member of the Commission. We have always appreciated your willingness to be available for us when we need your counsel and advice. I personally as well as on behalf of the committee welcome you here, and appreciate your being here.

STATEMENT OF DR. HENRY DEWOLF SMYTH, CHAIRMAN, BOARD OF SCIENTIFIC AND ENGINEERING RESEARCH, PRINCETON UNIVERSITY

Dr. SMYTH. Thank you very much, Senator Anderson. I was glad to be invited to come down here and testify and hope I can say something that may be useful to you.

My name is Henry DeWolf Smyth and my present position is chairman of the board of scientific and engineering research of Princeton University. I also hold the Joseph Henry professorship of physics at Princeton. From early 1941 through 1945, I worked in various scientific and administrative capacities connected with the development of atomic weapons by the United States Government. From June 1949, until my resignation on September 30, 1954, I was a member of the Atomic Energy Commission. For the last year and a half I have been primarily concerned with research projects in science and engineering at Princeton, many of them carried out under contract with the Government, including the research project on thermonuclear energy for peacetime use. I served as consultant to the Atomic Energy Commission. I also do some private consulting.

In my testimony today, I am giving only my personal views of the nature of the problems involved in reactor development and on how these problems may best be solved.

I advocate a vigorous and varied program of reactor development in this country. The experience and skill of private industry are essential in this program, and every encouragement should be given to private industry to go forward as rapidly as it is willing to do. In this new field of atomic power, I believe the Government must continue to point the way, with sustained and imaginative effort, until we know much more about reactor technology than we do at present. I believe full cooperation of Government and industry in atomic energy will continue to serve this country best.

INTERNATIONAL REASONS FOR STRONG PROGRAM OF REACTOR DEVELOPMENT IN THE UNITED STATES

There are three principal reasons why the United States should pursue a vigorous development of nuclear reactors for the production of power. These reasons are: First, the responsibilities of our present world leadership; second; the implementation of our stated foreign policy; third, the rapid growth of our need for electrical power in this country.

In the past 15 years we have developed a great industrial technology devoted to the extraction of energy from uranium. It is generally recognized that at present we lead the world in this development. We have not been backward in claiming that the peacetime uses of nuclear energy can be an important factor in lifting the general standard of living everywhere. We are at present the richest country in the world and technologically the most advanced. The United States has a great opportunity and a great obligation to maintain leadership in the development of this new technology of nuclear power.

We have not only spoken of the importance for the world latent in peacetime use of atomic energy. Beyond that, this Government has now specifically offered to assist other nations in this development. Consequently we have a specific obligation to back up our foreign policy gestures in atomic energy with growing technological strength. This is the second reason why I believe we must maintain a vigorous program of reactor development. I do not see how we can offer to build reactors abroad without building enough such reactors here to know what we are doing. I do not see how we can expect to send materials and helpful information abroad if we let our domestic technology fall behind or become obsolete.

DOMESTIC REASONS FOR STRONG PROGRAM OF REACTOR DEVELOPMENT IN THE UNITED STATES

The third reason for pursuing a vigorous program here is the prospective growth of our need for electrical power. It is true that power in this country is now relatively cheap. It is true that we have great coal reserves. But our growing need for electric power has been clearly demonstrated in recent years. We have every reason to expect a rapidly rising demand in the years ahead. Our power needs in 1970 or 1975 will certainly be several times greater than our total electrical generating capacity at present. Possibly the coal industry, with help from oil and natural gas, can be developed to take care of these needs. But these conventional sources of fuel are not unlimited. We should be investigating now, long before our present fuel supplies are exhausted, every other promising source of energy. The fission of uranium is such a new source. Commonsense and national prudence alike require us to explore its possibilities.

Furthermore, even today some parts of this country find that distance from sources of fuel makes power expensive. It is highly probable that, in these areas, power from nuclear fission may become competitive in a relatively short time, even though in favored areas the coal industry may be able to supply power needs for a considerable period.

There is not much controversy about the reasons I have cited for a vigorous program of reactor development. Before discussing the nature of such a program, let me outline the technical situation as I understand it today.

RECENT STATE OF REACTOR DEVELOPMENT IN THE UNITED STATES

There is no question about our ability to extract useful power from the fission of uranium. We have done so on a small scale in many different nuclear reactors. We are doing so on a considerable scale in the reactor that drives the Navy submarine, *Nautilus*. Theoretically, there are many ways in which uranium or enriched uranium can be combined with other materials, coolants, moderators and so forth, to make a nuclear reactor which will furnish heat. In generating stations, this heat can be converted into electric power.

We do not yet know which type of reactor will produce power most cheaply. We do not know from direct experience whether any one of them will produce power cheaply enough to be competitive with other sources.

One reason that we do not know the answer to this economic question is that we have no reactor operating in this country today specifically designed to produce industrial power. Today, only one reactor for such a purpose is under construction. This is the reactor being built at Shippingsport, Pa., and it will presumably not begin operation until 1957.

To meet our military requirements since 1941, the Atomic Energy Commission has built two kinds of reactors on a large scale. Both types were designed for the production of plutonium, not for the production of industrial power. These reactors to produce plutonium are the graphite, light water, natural uranium reactors at Hanford and the heavy water, natural uranium reactors at Savannah River.

Power is being produced today in a third type of reactor, one of intermediate size, the enriched uranium, pressurized, light water reactor that drives the *Nœutilus*. Expense was not a major consideration in the construction of this submarine powerplant. Consequently, it provides little information on the future costs of industrial nuclear power.

Several other types of reactors have been built on a small scale and have been operated. Present planning will presumably give us intermediate-scale reactors of some half dozen different types within the next few years and one full scale power producing reactor of the pressurized light water enriched uranium type in that same period. This is the reactor I have already mentioned, which is under construction at Shippingsport, Pa. A number of other large power reactors are in various stages of discussion or design.

In addition to the operation of small-sized reactors of various types and the construction of intermediate sized reactors such as I have mentioned, the last 15 years have produced a vast accumulation of relevant technical data. Such information continues to accumulate. Studies on metallurgy, on heat transfer and on various types of fuel elements all contribute to the technology. The results of such studies can be combined to give some estimate of the probable success and probable cost of various types of reactors. But costs really will not be known until industrial reactors have operated.

In any technological development from laboratory to pilot plant to full-scale plant, the timing of successive steps is a matter of judgment. I do not believe there is any simple criterion which makes it possible to decide when the time has come to build a full-scale plant. No amount of work in the laboratory or even with a pilot plant will give a final definitive answer as to whether a full scale plant will work and, if it works, how much the final product will cost. In the field of atomic energy much of the technology is new. Complex political and economic questions are involved. In this new field of nuclear power, there is room for a difference of judgment among reasonable men as to what is the proper course to pursue, if we all agree on the importance of a vigorous program of reactor development.

SUGGESTED FUTURE PROGRAM OF REACTOR DEVELOPMENT

Let me outline what I consider an appropriate reactor program for this country for the next 5 or 10 years.

First, it is obvious that research on components of reactors, on the materials that are to be used in reactors and related subjects, should be continued. At present, this research is centered in Government laboratories. I do not think it woud be possible to remove it entirely from Government laboratories, but I think increasing work on more development aspects of this program should be taken up by private industry.

Second, pilot or small-scale plants should be built, incorporating new ideas or substantial modifications of old ideas. This program of reactor experiments or of pilot scale reactors is already well under way under the auspices of the Atomic Energy Commission, and should continue. This part of the overall program should also continue to be financed by the Government and run by the Commission.

Third, the Commission should continue to encourage construction of research reactors in this country and abroad. It should be recognized, however, that in many cases research reactors do not contribute very greatly to reactor technology. They are useful as training tools for students and research in other fields. They are not necessarily important to the development of reactor technology. The design and fabrication of such research reactors, for use either here or abroad, can well be continued by private industry, which has already built a number of such reactors.

Fourth, much greater effort should be placed by the Atomic Energy Commission on relatively small power-producing reactors for actual use. This recommendation is aimed directly at the support of our foreign policy. Small power-producing reactors may not be widely useful in this country at present, but may be very useful abroad, particularly in those countries where fuel sources are inadequate and where the need for electrical power is beginning to develop. Such reactors in such countries may offer us the earliest opportunity to demonstrate our leadership in atomic energy for peace.

Finally, when general research together with the operation of reactor experiments indicate that a new type of reactor will probably operate if built on a large scale and operate at a reasonable cost, the Atomic Energy Commission should see to it that such a reactor is built.

GOVERNMENT AND INDUSTRY IN REACTOR DEVELOPMENT

It is in the area of design and construction of new types of reactors that I foresee the greatest difficulty in deciding what the role of the Government should be.

Private industry must necessarily be concerned with immediate costs as well as with ultimate development. When a novel type of reactor is chosen and announced by private industry, there may be a temptation to minimize risk by a long period of preliminary research. It seems to me inevitable that as more and more reactors are built for the production of power by private utility systems, the tendency will be to build types of reactors already tested in practice, if such types give power at costs comparable with the average power costs of the systems. You will note that in the proposals already before the Commission there is a preponderance of pressurized, light water reactors. I believe that most experts would say that such reactors are not the reactors of the future.

Chairman ANDERSON. That is a very interesting statement, Dr. Smyth, because that is the very point that Dr. Zinn made in our discussion the other day. All of the effort seems to be going on one horse that might not be the horse of the future. We are putting our bets on it. I don't object to our putting some bets on it.

Dr. SMYTH. It is not all going on that one horse, as I point out in my next paragraph.

Chairman ANDERSON. I realize that.

Dr. SMYTH. I think there is a tendency which I think is natural.

The CHAIRMAN. I think that tendency might come because we have tried that one and it seems to work well in certain cases, and therefore the line of least resistance is that you don't gamble quite as much if you try something that has already worked a little bit.

Senator GORE. In other words, Mr. Chairman, the gamble is not quite as great because the Government itself has demonstrated the feasibility of the process, which is what I propose that the Government would do with others on a larger scale.

Senator ANDERSON. I just can't put my finger on the name of the philosopher who said something to the effect that the route to success is to travel with others; the route to immortality is to travel alone. Sometimes we have to travel alone in this business, if you hope to produce anything outstanding and unusual.

Dr. SMYTH. Shall I continue?

Chairman ANDERSON. Yes, indeed.

Dr. SMYTH. I am very glad to see among the reactor proposals, however, the fast breeder proposed by Detroit Edison and the boiling reactor proposed by the Commonwealth Edison of Chicago. Both of these types are fairly radical in conception and should prove extremely interesting steps in the development of cheap and efficient nuclear power. I hope these reactors will be built rapidly even if some technical risks have to be taken.

Chairman ANDERSON. May I say right there that I would add at least a very strong endorsement for that statement. I hope they will be built rapidly. That is why I am glad to see the Government trying to cooperate with these people who are sponsoring these reactors. I do believe that they will greatly advance reactor technology.

Dr. SMYTH. It is extremely difficult, Senator Anderson, to make a judgment of how great risks should be taken. You obviously don't want to build a reactor that won't work. But perhaps you should take greater risks than you would in a conventional powerplant.

I see no way of assuring an adequate and well-rounded program of reactor development and construction without Government leadership. The Atomic Energy Commission should be ready to build promising types of reactors that for one reason or another do not attract private capital. The Commission must not only conduct research and build reactors of experimental size, but it must also build full-scale power-producing reactors when necessary to fill gaps in the national program.

The atomic energy industry started as a Government monopoly. We hope that eventually it will be divorced from the Government except in terms of regulatory functions. It is clear that this transition cannot be made quickly or easily. We are now in a period where Government and private industry must work as partners.

It is more important for this country to push a vigorous program of developing peacetime uses of atomic energy than it is to get the Government out of the nuclear power business. The thing that matters is to get ahead with the program. I think it would be a great mistake for the Government to lag in its support of the development of nuclear powerplants, either in this country or abroad, simply in the hope that such a lag on the part of Government will speed the transition to private initiative and responsibility. As I suggested at the beginning of this testimony, there are too many questions of national policy involved in this whole program of nuclear power development to allow the Government to avoid continuing responsibility in this field.

Chairman ANDERSON. Dr. Smyth, I used to observe Gen. George Marshall when he was Secretary of State. He would read a report of world conditions, and he would read one sentence that had great importance to it, and he would stop and sort of pull his glasses a little bit, and say, "I think I will just read that again." I wish you had stopped and read that first sentence of that paragraph.

It is more important for this country to push a vigorous program of developing peacetime uses of atomic energy than it is to get the Government out of the nuclear power business.

I think that is a very fine statement. We want to get the Government out of it in time. Everybody feels that way about it. But it is very important worldwide to push a vigorous program of developing peacetime uses of atomic energy. You can see the temper of the Congress when they cut a billion dollars out of the foreign-aid bill that was going to go for armed aid or weapon assistance. That program may be coming to an end. There is a good deal of determination that it shall. The one thing that I think will replace it, and replace it in a very effective fashion might be the building of reactors in these other lands.

Senator Pastore pointed out yesterday that it was fine to allocate a great amount of material for a world pool, but if they didn't have a reactor to burn it in, it didn't mean very much.

Dr. SMYTH. Yes. I am afraid that is true.

CONCLUSION

It is clear that the Congress has the responsibility of giving the Atomic Energy Commission both the authority and the money to build such nuclear power reactors as are needed in addition to those built by private industry. I think it is also clear that the Congress can appropriately advise the Commission to build such reactors as are needed in addition to those built by private industry. I think it is also clear that the Congress can appropriately advise the Commission to build such reactors, if the Congress feels that the whole program is lagging behind the rate desirable in terms of national policy. I believe it would be unwise for the Congress to order the Commission to build powerplants of particular numbers or types, or in particular locations. I question the necessity for specifying that a given type of reactor should be built at Government expense in addition to one of the same type already under construction by private industry. Technical judgment should be left to the Commission. The Congress can and should make clear what it considers the appropriate rate of progress.

The recommendations on atomic power made by the McKinney panel very nearly represent my views:

> We recommend: (1) That the Congress, the American people, and the people of the world recognize that large sums of money and years of effort must be spent to bring atomic power to a point where it can be used effectively and widely on a competitive basis; unless and until research and development demonstrate that atomic power can be economically feasible, there can be no substantial impact; (2) that, in the event that industry does not take on the full risks and burdens, the Commission should support a program to bring atomic power to a point where it can be used effectively and widely on a competitive basis, even to the construction with public funds of one full-scale "demonstration" plant of each major reactor size and type; (3) that the urgency associated with this program requires that the technological resource of atomic power be fully explored with high priority; and (4) that atomic power be exploited as a source of electric power at a rate consistent with sound technological, economic, and public policy considerations.

In 1950 the Atomic Energy Commission began a very great expansion of its laboratory and plant facilities. This expansion of the Atomic Energy Commission program was made possible by the confidence and cooperation existing between the Commission and the Congress. In the complex field of peacetime production of nuclear power, an equal cooperation between the legislative and executive branches of the Government will be essential. With such cooperation, and with the similar partnership of private industry and Government, we can hope to maintain the leadership we have today.

Chairman ANDERSON. Dr. Smyth, if you don't mind, I would like to just have printed in this record at this point when we come to the final printing of it from the appendix to the report, Current Statement of the Atomic Energy Commission on the 5-Year Reactor Development Program to the Subcommittee on Research and Development. That appendix carried the remarks prepared by Henry D. Smyth, member, United States Atomic Energy Commission, for delivery at the National Meeting of the American Institute of Chemical Engineers, Washington, D. C., March 9, 1954. If you have no objection I would like to take up item 5 which gives the history of the reactor program under the heading, "The First Atomic Energy Com-

mission Reactor Program," and reprint it in the record at this point. (The information is as follows:)

V. The First Atomic Energy Commission Reactor Program

When the Atomic Energy Commission took over the plant and equipment of the Manhattan District in January 1947, the problems that I have been reviewing were already clear. Although the Commission's first responsibility was to prosecute the atomic weapons program with vigor, it soon turned to the possibility of atomic power, both for special military purposes and for ultimate peacetime uses. Early in 1949, Dr. Bacher, my predecessor as the scientific member of the Commission, made a speech in which he outlined the ways in which the Commission was attacking the problems I have reviewed. Essentially, the program consisted of a plan to build four major reactors. Let me describe three of these that have been finished at our Idaho test site and why they were built.

The first of them was the so-called materials testing reactor, MTR. It was aimed primarily at getting information on the effects of radiation on uranium fuel elements or other materials that might be used as tubes for cooling water, or as coolants, or containers for uranium fuel elements. The object of this reactor then was to provide very high intensity radiation in a machine so designed that many experimental samples could be placed in it. It has now been running for about 2 years, and it has in fact proved exceedingly useful. Incidentally, it also was a novel kind of reactor and therefore was in itself a step toward the development of new types of reactors.

The second reactor built at Idaho was the so-called experimental breeder reactor, EBR. As the name implies, it was specifically aimed at demonstrating whether or not breeding was possible. It has demonstrated that breeding is possible and has had a number of other incidental interesting results.

The third reactor was a special purpose one aimed at providing power for a submarine. You have heard a great deal about that one and about the submarine in which a similar reactor is now being installed.

In all three of these reactors, the neutron economy problem was solved by using uranium from which much of the uranium 238 isotope has been extracted. Whether or not in the long run, this is the kind of reactor we will build for power purposes will be largely a question of economics. Personally, I doubt it, but I do not doubt the wisdom of having built these three reactors and the value of the results we have obtained from them.

A more modest undertaking initiated later is the homogeneous reactors experiment at Oak Ridge. From the atomic point of view, the homogeneous reactor is misnamed. In reality, one can think of it as a lattice where the spacing is very small and the size of the fuel elements is of atomic dimension. To put it more simply, and in terms that will be more familiar to you, the homogeneous reactor is a solution of uranyl sulphate in water. The water serves as the moderator, and the uranyl sulphate molecules serve as the fuel elements in which the chain reaction is set up.

The immediate and obvious advantage of the homogeneous reactor is that fuel fabrication and processing is enormously simplified. The solution is pumped continuously through the reactor chamber and then cooled in outside heat exchangers, and some of it can be continually led off for purification and then reintroduced into the circulating stream of combined fuel and moderator. One of the interesting features of the homogeneous reactor is that it turns out to be self-regulating. As the temperature of the reactor rises, its reactivity decreases and therefore it controls itself. One difficulty that was anticipated in the homogeneous reactor was that the water itself would be dissociated by the radiation. This does occur, but it has been found possible to recombine the hydrogen and oxygen formed without too great difficulty.

In addition to the results obtained with the three reactors I have been discussing, and the homogeneous reactor experiment, there has, of course, been an extensive program of study of the various associated problems in the laboratory. These range from fundamental studies of what causes radiation damage, or of the absorption probabilities of various materials for neutrons of various energies, to component testing in heat loops, and experimental fabrication of fuel elements. Some of these studies use the various low-power research reactors that have been built.

One of the most interesting experiments that has been done was carried out last summer at the Idaho test site by Dr. Zinn, director of our Argonne Labora-

tory, and his associates. We had long worried about what would happen to a water-cooled reactor if the flow of water should be cut off. We were afraid if the water supply was cut off or if the temperature of the reactor rose too rapidly boiling would occur and that this might have disastrous results. Dr. Zinn decided to make a direct approach to this problem and built a small reactor with the deliberate intention of producing boiling. When it was set up at the Idaho testing station, it had an arrangement in it which suddenly ejected the control rods so that the power generated by the chain reaction went up in a fraction of a second from a few watts to many thousands of watts. This had the expected effect on the water. It boiled. It boiled so violently in fact that it was ejected from the reactor in a small geyser. Repeated trails showed that in every case the boiling reduced the power of the reactor so rapidly that no serious damage was done.

This particular experiment illustrates very well the reasons for choosing an isolated area as a site for experimental reactors. It was not only that some of the reactors might be inherently dangerous, but it was felt that an experimental reactor, one built primarily for the purpose of obtaining information, should be operated to extremes, and that it was desirable to have them in an isolated location for that reason. In other words, if you want to get as much information as you can out of a reactor, you need to push it to the point where it might conceivably run into trouble.

Dr. SMYTH. I should be very much complimented, Senator Anderson.

Chairman ANDERSON. I think it is still worth reading, very much so.

Do you have any questions, Senator Gore?

Senator GORE. I don't believe I have questions. I think Dr. Smith has made a fine statement. It deserves consideration of the entire committee. He has had eminent experience in this field, and I think has put first things first, which must be the national interest, rather than the private interests.

Chairman ANDERSON. Thank you very much for coming and for your patience.

Dr. SMYTH. Thank you, sir.

Chairman ANDERSON. Dr. Daniels, I understand you do not have a prepared statement. I wish you would identify yourself for the record and allow me to say before you start that we are very happy to have you here. I know that you have many ideas on this subject, and, even though you were not invited in time to prepare a statement for it, your opinions are worthwhile to us, and your ideas are what we want to have. I appreciate your coming on the rather short notice, because I wanted very much to have the benefit of your advice and counsel.

STATEMENT OF DR. FARRINGTON DANIELS, CHAIRMAN OF THE CHEMISTRY DEPARTMENT, UNIVERSITY OF WISCONSIN

Dr. DANIELS. Thank you very much, Senator Anderson. I do not have a prepared report. If you want me to supplement these remarks, I will be glad to write more later. I presume the hour is late, and I should try to keep within 10 minutes.

Chairman ANDERSON. You go ahead. Will you identify your activities? Are you connected with the University of Wisconsin, and, if so, in what capacity?

Dr. DANIELS. I am chairman of the chemistry department at the University of Wisconsin.

Chairman ANDERSON. Are you a past president of the American Chemical Society?

Dr. DANIELS. Yes; in 1953.

Chairman ANDERSON. Were you at one time director of the Metallurgical Laboratory of the Manhattan District?

Dr. DANIELS. Yes; in 1945–46. Then I was chairman of the Board of Governors of Argonne Laboratory from 1946 to 1948.

Chairman ANDERSON. Thank you. Lawyers would know how to qualify you for a witness. I have to stumble around a little bit, but I am happy to have you qualified as a witness.

Dr. DANIELS. Thank you.

Chairman ANDERSON. You may proceed.

Dr. DANIELS. I find myself in close agreement with what Professor Smyth just said. I feel that we should encourage new ideas and if the Government laboratories and private companies are too busy with other things, there still ought to be some mechanism by which new types of reactors can be developed. Ordinarily private enterprise can take care of itself in these newer developments. But in this case the investments are so very large, and the tie-up with the Atomic Energy Commission is so important and vital that perhaps more encouragement might be given to some of the smaller companies that have ideas which are too big for them to swing.

Let me go back into a bit of history. I have been advocating a gas-cooled power reactor since 1944. This plan was adopted by the Manhattan District, and we had a directive to design, build, and operate a gas-cooled power reactor as rapidly as possible. It was transferred from Argonne to Oak Bidge, and we were given $3 million to do the job. We collected a fine group of engineers and scientists, and made an excellent start—but unfortunately the program was canceled in 1947. After that the group disintegrated and some went into what eventually turned out to be the submarine. But we did have a design for a gas-cooled reactor.

I feel this is a neglected field. No one that I know of is working on gas-cooled reactors at the high temperatures which we have advocated.

At Geneva I was interested to see the design of other countries. Gas-cooled reactors are in operation in plants in England and France and presumably in Russia. I would advocate a bolder approach. I would advocate going to much higher temperatures than have been planned thus far.

The program which I would like to see followed is summarized in this article published in Nucleonics for March 1956, pages 34 to 41. A Small Gas-Cooled Reactor. I must not go into detail, and I must not advocate my own particular plans too much, but I would like to summarize in just a few minutes why I think this type of reactor should be encouraged.

Chairman ANDERSON. May I ask you this question before you do? When you say through the Manhattan District a decision was reached in 1944 to build a gas-cooled reactor, and a group of you were sent to Oak Ridge; did they consider other types of reactors at that time and decide that this seemed to offer the best possibility for immediate construction?

Dr. DANIELS. Yes. This was not in 1944. This was in late 1945 and early 1946 that the Manhattan District made the decision. Yes, they thought that this was a program for atomic power which should be explored and gave us $3 million to do it with.

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Chairman ANDERSON. So it is not something that has never had any study by anybody else.

Dr. DANIELS. That is right.

Chairman ANDERSON. It is not purely your own theory that you worked out. A great many people participated in that.

Dr. DANIELS. That is right. The Monsanto Co. was given a contract, and they had 40 engineers and scientists from General Electric, Westinghouse, and various other companies and laboratories and universities.

Dr. ZINN. I think it would be right to say, Senator Anderson, that when we studied possible reactors for the submarine we really did a study job on three kinds—the gas-cooled reactor, which Professor Daniels had proposed, the water-cooled one, which is the *Nautilus* plant, and a sodium-cooled reactor, which is some version now is in the *Sea Wolf*. For the submarine the gas-cooled was not the reactor, we didn't believe, because it takes too much space. But it was studied just as thoroughly as the others and was not chosen for the submarine, not because it is not a good reactor, but because it doesn't fit in a submarine.

Mr. RAMEY. The submarine got the priority for the program.

Dr. ZINN. That came afterward. It has been reviewed in that connection at least once. The gas-cooled reactors which have been studied since then have not been quite the type that Professor Daniels had proposed, but rather the type which is now under construction at Calder Hall, a lower temperature gas-cooled reactor.

Chairman ANDERSON. You said you would take a bolder approach and use a somewhat higher temperature.

Dr. DANIELS. Yes, in our designs we were trying to make things as cheap as we could. We had plenty of space. The Navy had to have a small size and economy was not so important.

Chairman ANDERSON. When you get into a rush defense job, dollars are not the most important factor.

Mr. DANIELS. That is right.

Now, may I summarize in 5 minutes what I would like to see done. It applies only indirectly to this bill perhaps, but it does apply. Practically all the designs anywhere in the world that I know of now have metal parts in them. This forever prevents going to high temperatures. The high temperature enables one to get greater heat transfer, and it enables one to have a higher thermodynamic efficiency. The metals used in these reactors are subject to radiation damage and change of shape. They are subject to melting and many are subject to corrosion. So the line that I would like to see explored is the construction of an actual reactor, made entirely of graphite with uranium carbide for a fuel. I have a fuel cartridge here. It is just a graphite rod bored out with uranium carbide powder in it. This would be cooled with helium. The helium under 15 atmospheric pressures would be circulated through a heat exchanger up to 1,300° F. This heat exchanger would heat air or nitrogen and operate a gas turbine.

The gas turbine approach seems to be important for the future. Most of the present designs have metals inside the reactor, which are subject to melting, and they have to be kept at temperatures which are too low to operate a gas turbine. The melting points of the graphite and the uranium are above 4,000° F. With this big safety

factor one can go to temperatures far above the melting points of iron, zirconium, and other metals. It seems to me that this type of a reactor is safe in that there is no change of phase, no large volume changes from water to steam, and nothing to melt. The nuclear constants are well known.

This proposal emphasizes chemical processing. The cost of the chemical processing is one of the important limiting factors in the economics of atomic power. If you have to process the fuel, take out the fuel rods, dissolve them, treat them chemically and get back to metals in the particular machined shapes—it is expensive business. If the reprocessing has to be done frequently with perhaps a few percent burn-up of the fuel, then it becomes impossibly expensive. The approach proposed here would use uranium carbide, which would be burnt to uranium oxide in the partially spent fuel and dissolved in nitric acid, separated from fission products and precipitated and converted to uranium carbide. All the costs of metal production and machining are eliminated.

This is getting technical, I fear. I want to point out that it is simple and safe and it is cheaper with respect to chemical processing. I have had many years of conferences both inside the Atomic Energy Commission and outside, and I have had no really significant technical criticism that the approach is unsound. Others perhaps disagree on the cost and so on, but I think that there has been no significant technical criticism that it is not practical.

I would advocate a 5,000-kw. unit built right away without any further laboratory work. The reason I suggest a small 5,000-kw. unit, which is small, is that it is possible for immediate construction. There is a firm in Switzerland, which will deliver a 5,000-kw. gas turbine proved and ready to run in a year and a half for about $600,000.

Chairman ANDERSON. In a year-and-a-half delivery?

Dr. DANIELS. Yes, and while the reactor is being built, the gas turbine could be built. I would like to see this program go forward rapidly.

One criticism is that these are small units. A 10,000-kw. turbine can be delivered in a couple of years, or a year and a half later, perhaps. Even 10,000 kw. is not interesting in this country because one can't have cheap electricity in 10,000-kw. units. But in the foreign field it is different. At Geneva, you may remember Senator Anderson, Dr. Libby asked if anybody was interested in 2½ cent, kilowatt-hour-electricity in small units. We are not interested in this country, but India appeared to be much interested.

The fact that gas turbines are not available now in larger than 10,000-kw. units should not be a great handicap. One could multiply these units and there are certain advantages in multiplying smaller units in a nonindustrialized country for shutdown and so on. Large sized gas turbines will come later when needed. I believe that it would cost perhaps $2 or $3 million. I believe that we can learn more—this was the attitude I took back in 1947, when the program was canceled—by building a unit and operating it than we can by long-continued laboratory experimentation.

The actual cost of the research over a period of several years would be as much as the cost of the building of the actual power unit.

Chairman ANDERSON. Does the proposal of Ford Instrument Co. bear any relationship to yours?

Dr. DANIELS. Yes. This company is proposing to use one of these gas turbines. It is cooled with gas. But there are metals in the power reactor, and which may get fairly close to the danger limit on the temperature.

Chairman ANDERSON. You would not use metals?

Dr. DANIELS. I would not have metals inside, except for control rods. For control rods I would us a very high melting metal like molybdenum, so nothing in the reactor would gassify and nothing would have a melting point less than 4,000° Fahrenheit.

After this Nucleonics article appeared, several people have written or talked with me about this design of a gas-cooled graphite uranium carbide reactor. I felt that 2 or 3 middle-sized corporations might undertake the continuation of this type of reactor except that they can't absorb the $2 million investment. The atomic energy laboratories are doing a fine job and the big industries are doing a fine job, but they have their own reactors, and they are thinking in terms of water and metals. This is the standard procedure and the work certainly should continue. They are not interested in taking up one of these bolder approaches and more radical designs. Support of this type of reactor might fit into the kind of program you are talking about.

Chairman ANDERSON. Thank you very much. I appreciate your coming down. I am particularly happy that you have revived this gas-cooled project, because many of us think that it is a bet that we should not be overlooking.

Senator GORE. You would agree with Dr. Smyth's statement that first importance should be maintaining this country's lead in this field.

Dr. DANIELS. Yes, I do, very much so. I feel that this type of reactor, which, in my opinion is simpler and safer, would find immediate use in isolated places and particularly in nonindustrialized countries.

I have been in India, and I have a feeling that one of the best ways we can make friends there would be to help with India's atomic energy program in a practical way.

Senator GORE. Would you agree that there are important designs and processes, though it might not necessarily be true with this one, the feasibility of which could only be tested in large-scale production?

Dr. DANIELS. Yes, sir. I have been saying that for many years. For example, the extent to which the fuel can be consumed before it has to be reprocessed is a vital thing in the cost of chemical processing. There is no way that I know of by which the extent of fuel burn-up can be fully determined except by operating a reactor. It would not cost more money than a few years of research would cost to find out quickly under actual working conditions how far one can go before he has to reprocess the fuel. Radioactive contamination, too, needs to be studied under working conditions.

Senator GORE. Doctor, maybe you would not want to respond to this question because it may be out of your field, but I will ask the question and you can reply if you like. Do you see any essential difference insofar as philosophy or ideology or political principle is concerned between the Government building a hydroelectric dam to

develop a natural resource on the one hand, and the Government building a reactor to develop an atomic natural resource on the other?

Dr. DANIELS. I don't feel myself an expert in this field. Let me just quote from my closing remarks as chairman of the division of energy of the Mid-Century Conference in Washington a couple of years ago. I think the Government has done a swell job, and I think private enterprise has done a swell job. There is plenty of room for both of them, and I am sure they can work together. There is room for each one in its own way. I think the atomic atomic power certainly comes into this cooperative field.

Senator GORE. In addition to there being room for both, would you say there is a need for both?

Dr. DANIELS. Yes; certainly.

Senator GORE. Thank you.

Chairman ANDERSON. Thank you very much.

We will meet in the District room again tomorrow morning at 10 o'clock.

(Whereupon, at 5:45 p. m., Thursday, May 24, 1956, a recess was taken until Friday, May 25, 1956, at 10 a. m.)

ACCELERATING CIVILIAN REACTOR PROGRAM

FRIDAY, MAY 25, 1956

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D. C.

The Joint Committee met at 10 a. m., pursuant to recess, in room P–68 of the Capitol, Senator Clinton P. Anderson (chairman of the Joint Committee) presiding.

Present: Senators Anderson, Gore, and Jackson; and Representative Price.

Present also: James T. Ramey, executive director, George Norris, Jr., George E. Brown, Jr., Wayne P. Brobeck, and David R. Toll, of the Joint Committee staff.

Chairman ANDERSON. The Joint Committee will be in order.

Our first witness is Charles E. Oakes, president of the Pennsylvania Power & Light Co. We are glad to see you, Mr. Oakes.

STATEMENT OF CHARLES E. OAKES, PRESIDENT OF THE PENNSYLVANIA POWER & LIGHT CO.

Mr OAKES. My name is Charles E. Oakes. I am president of Pennsylvania Power & Light Co., a company which furnishes electric service to more than 680,000 customers in an area of some 10,000 square miles in central eastern Pennsylvania. I appreciate very much the opportunity, gentlemen, of appearing here today in connection with the committee's consideration of the Gore bill, S. 2725.

The present direct interest of the Pennsylvania Power & Light Co. in atomic energy matters stems from the joint program now under way with Westinghouse Electric Corp. to develop a homogeneous type reactor as the heat source for a powerplant of approximately 150,000-kilowatt capacity. This program has been under way for about 1 year and we believe that good progress is being made. Because development of a homogeneous reactor involves a new field and considerable new technology, substantial research work is required. A staff of scientists and engineers has been set up and provided with facilities to do this necessary work. We now anticipate that by mid-1958 we will be able to proceed with the detailed design and construction, looking to an inservice date of 1962.

Our program is, of course, only one of several programs which the industry is actively engaged in carrying out at this time. I will not go into the details of these programs because they are a

matter of record in the hearings before this committee. It is important, however, to note that this information of record shows that the electric utility industry, in association with equipment companies, parts suppliers, and chemical companies, and together with AEC, is carrying out an aggressive program to develop the several types of power reactors which hold promise of providing economic power generation.

Because of this, it simply does not make sense, to me at any rate, that the Congress should undertake through some means, such as S. 2725, the construction of power reactors over and above the power reactors now covered by the programs of AEC and the electric utility industry. Doing so would duplicate existing work and existing expenditures. It would subtract from the available supply of brainpower which is already fully engaged in nuclear programs for AEC and industry, and the Defense Establishment.

I know of no case in which the Government of the United States has forcibly intervened to take over an industrial program of commercial application where the industries involved were prepared to do the job, and were in fact proceeding with an all-out effort to do that job.

Chairman ANDERSON. Are you familiar at all with the aviation industry?

Mr. OAKES. Somewhat; yes, sir.

Chairman ANDERSON. Is it your opinion that every one of the liners that we have, like the DC–7, and the Constellations, and the Super Constellations, were developed by the airline companies without any previous commitments on the part of the Federal Government toward military types?

Mr. OAKES. No, sir; I think there was substantial advantage taken of the development of military types in the development of the application of commercial programs.

Chairman ANDERSON. Are there any jet airliners being made in the United States other than military?

Mr. OAKES. I think not. However, the commercial airlines are, of course using that development.

Chairman ANDERSON. In order to get us into the airplane business and the jet business particularly, the military took a good deal of the lead and the developmental costs, I think, in the shipping business. Who built the United States Lines' newest ships?

Mr. OAKES. I appreciate that.

Chairman ANDERSON. Well, who did, though?

Mr. OAKES. The Government built those.

Chairman ANDERSON. It says, "I know of no case in which the Government of the United States has forcibly intervened to take over an industrial program of commercial application where the industries involved were prepared to do the job." Were they prepared to do the job?

Mr. OAKES. What I am saying here is that an industrial program of commercial application, where the industries involved are prepared to do the job—I do not know whether the marine commercial industry was prepared to do the job. What I am saying here——

Chairman ANDERSON. It was prepared to do what it thought was a job but the Government found we were losing our steamship business and they would do nothing unless the Government intervened.

Mr. OAKES. What I am saying here, Senator, is that the public utility industry is prepared to do this job, and under those circumstances the Government of the United States should not intervene.

Chairman ANDERSON. Do you think that private industry is prepared to build a gas-cooled reactor?

Mr. OAKES. If it is an economical application; yes.

Chairman ANDERSON. You mean if the Government works out the economical application.

Mr. OAKES. No, sir.

Chairman ANDERSON. They might do the job then.

Mr. OAKES. If our engineers and our scientists in this country, including the Government, would come up with a gas-cooled reactor, I do not mean already built, but one where the idea looked like it might be an economical application, industry would take that forward and go on with it.

Chairman ANDERSON. The point is that the Government does have some thoughts along that line, and industry has not even tried to do it. We were talking the other day about the Hanford-type reactor and Dr. Zinn had some testimony there as to the fact that we might be able to do something with that. Industry is not anxious to do it. Do you think industry is going to cover all of the possible types that will be necessary to keep this country going?

Mr. OAKES. Of reactors, you mean?

Chairman ANDERSON. Yes.

Mr. OAKES. I have no knowledge, technical knowledge, and I do not think I am qualified to answer that question.

Chairman ANDERSON. This is the New York Times of Thursday, May 24, and I assume the same story is carried in practically every paper, but it has a London dateline of May 23:

The British Atomic Energy Authority announced today that the first of two atomic piles on the Calder Hall Atomic Power Station in Cumberland had begun to work. Construction of experimental stations began 3 years ago.

Then I quote from the statement:

For the first time in the history of the world, electricity on a large scale will then be supplied from a nuclear power station to a national electricity network, the statement of the Atomic Energy Authority said.

Are you familiar with whether or not that is a gas-cooled reactor?

Mr. OAKES. Yes, it is, I understand.

Chairman ANDERSON. Does any American industrial firm that you know anything about or have heard anything about plan a gas-cooled reactor?

Mr. OAKES. Not that I know of.

Chairman ANDERSON. Would it interest you to know that on this same page, and just under a small heading below it, it says:

SOVIET ATOMIC PLANTS

In a letter from Moscow special to the paper, saying the Soviet Union plans to install most of its new atomic powerplants in the European part of the country because of fuel shortages.

It discusses it and then it tells what they are going to do and that there is a gas-cooled reactor in their program. It quotes Mr. Kurchatov as saying:

The plants range from 400,000 kilowatts to 600,000 kilowatts each.

How many of the new plants that are scheduled in this program to which you referred are between 400,000 and 600,000 kilowatts each?

Mr. OAKES. None that I know of.

Chairman ANDERSON. Well, does that not begin to suggest that possibly it might be all right to open this up a little bit and see if somebody had another idea? Do you mean you want us steadily to stay behind Russia and Britain in this field?

Mr. OAKES. No, sir; I do not want that.

Chairman ANDERSON. Why do you object to our trying to get ahead?

Mr. OAKES. In the first place, these reactors, English reactors, it is my understanding, will not result in a cost per kilowatt hour produced that will be anywhere near the present experience in the United States with conventional fuels.

Chairman ANDERSON. The one that you are contemplating, does that come down to the cost of conventional fuels in the United States?

Mr. OAKES. We hope it will when we have it fully developed.

Chairman ANDERSON. Well, these British, when they are fully developed may do the same thing, but they are not going to hold off and wait for that day. They are proceeding to develop it. The very thing you say about them is applicable to everyone. Were you against the Shippingport reactor that Duquesne is building in the State of Pennsylvania?

Mr. OAKES. No, sir, in fact Pennsylvania Power & Light Co. and Philadelphia Electric Co. were bidders on that particular plant.

Chairman ANDERSON. Now, the rate will be very high. Why in the world would you want to build a plant like that?

Mr. OAKES. In order to advance the art.

Chairman ANDERSON. Precisely, and now it is all right to advance the art in America, and wrong to advance it in Russia.

Mr. OAKES. No, sir; that is not the point. I do not think that is the point.

Chairman ANDERSON. The point is that it is the Government over there, and the Government proposed in the Gore bill, and if it could be done by private industry, it would be all right.

Mr. OAKES. No, sir; that is not true.

Chairman ANDERSON. I do not follow you on that.

Mr. OAKES. This industry, the electric utility industry, is anxious to advance the nuclear power art. We have in this industry—or we have in this country, a period of time in the next 10 to 20 years when generation by conventional power is going to require, I would say, 40 to 50 or perhaps more percent of the total output of the coal mines. We will need a new type of power, a new method of generating power in this country. This nuclear power development evidently is the one thing we have been searching for.

This industry of ours has been, with a long history of development, continually lowering costs of generation in this country. You can bank on it that we will continue to do that very thing with respect to nuclear powerplants.

Chairman ANDERSON. But do you recognize, Mr. Oakes, that there is no great spur for the development of atomic energy in the United States because of the very successful operation with conventional fuels?

Mr. OAKES. Yes; there is.

Chairman ANDERSON. The financial spur is is not there, is it?

Mr. OAKES. Oh, yes; it is. We cannot think of our economics in our industry in terms of 2 or 3 or 4 years. We are now, all of us, looking forward to some new competitive type of power, and we are all of us, leaders in this industry, perfectly willing to spend a reasonable amount for research, put money on research and development to achieve that objective.

Chairman ANDERSON. Now you mentioned a moment ago that cost of the power in Britain. Would you mind giving us that, because thus far the Joint Committee has not been able to get that figure. I would like to have you furnish it for us.

Mr. OAKES. Which figure is that?

Chairman ANDERSON. The cost of the British power.

Mr. OAKES. From nuclear energy?

Chairman ANDERSON. Yes.

Mr. OAKES. I do not have it, the exact figure, with me, but I would be glad to furnish estimates. I think it is of the order of 8 mills to a cent.

Chairman ANDERSON. If you make certain allowances for the value of plutonium?

Mr. OAKES. Perhaps. I am not familiar with that. I am talking entirely from recollection, and I would have to get this figure.

Chairman ANDERSON. Well, I think that our only difference on this, perhaps, might be this: I do believe it is possible to have low-cost electricity from falling water or conventional fuels. Now, you are not able to expand falling water and it steadily decreases even though you brought in Niagara-Hudson power temporarily and brought in various other things. The overall supply of falling water is not going to increase very much in the next generation. As you said, coal seems to have some sort of ceiling on it, and it may be more valuable for chemical purposes than it is for fuel generation.

Mr. OAKES. That is correct.

Chairman ANDERSON. And oil is going to be needed to run the 85 million automobiles that we are going to have in 20 years, as against the 60 million that we have now. Therefore, there is a need for a new fuel, but we can be leisurely about it if we want to. Economically, that is probably correct.

But if you are worried about what is going on in other parts of the world, we cannot afford to be so leisurely about it, and if you hope to have American reactor plants operating in other parts of the world you cannot be leisurely about it. Russia is proceeding to do something in Red China that it could do in other parts of the world. I would think that the industry, while the industry might say to itself, "We are reasonably safe, and we can afford to wait as you folks are waiting until Oak Ridge has done additional research work on the type of reactor that we hope to build"—you said you were not going to be able to reach a decision on it until 1958, whether you are going ahead with it. You can take it leisurely, but the country cannot, and what we are trying to say is that even though you can afford to take it leisurely, why should the country not go ahead and test out two or three types of reactors that seem to have promise, even though no commercial company has come to the Commission and said: "We would like to build that."

Mr. OAKES. Senator, I want to emphasize that we are not taking our research and development on our type of reactor, the homogeneous reactor, leisurely. We have been assured by the staff at Oak Ridge that we have made wonderful progress on the work we are doing. I would like you to question Mr. Weaver, of the Westinghouse Co., who is much more capable of giving you the details of that, and he knows the scientific engineering phases much better than I do.

As to the advances we have made, we are bending every effort and we are spending real money to advance this just as quickly as we can advance it. But it takes development work, and you cannot construct, and you cannot design a reactor until you know whether the material that will be used and the processes that are to be used are going to be reasonably successful, or have a chance to be. That is what the research work is going on for, and that is what will be determined. We are pressing it with every facility at our command.

Chairman ANDERSON. Yesterday we had a professor from the University of Wisconsin here with a special report on gas-cycle reactor types, small gas-cycle reactors. This is not exactly the same, I think, as the pattern that we had in 1944, but would it surprise you to know that the Government came very close to constructing one of these starting somewhat after 1944, and gave Monsanto a contract, and appropriated $3 million and they were going to build one? They were trying to find out something about this type. It was abandoned, and the gas-cycle reactors have not been thought of very much since, but somebody thought it was pretty good. He thinks it is still pretty good.

Mr. OAKES. I am not capable, and I have not the technical knowledge to tell you whether it is good or bad.

Chairman ANDERSON. But no American company wants to build it. I am trying to find out what is wrong, under those circumstances, if a great group of scientists think it has possibilities, what is wrong with building one of these? Will 10,000 kilowatts upset the whole American market?

Mr. OAKES. I would say that if the engineers and scientists in the manufacturing industry and in our industry were convinced that this had possibilities, you would find somebody would step up and do the job.

Chairman ANDERSON. Well, one man said he was convinced but he could never find anyone he could convince. It may take a while. Sometimes you do have to gamble in the dark.

Mr. OAKES. The industry, as I understand it, has the choice of several, or many types of reactors and designs of reactors.

Chairman ANDERSON. That is right.

Mr. OAKES. Those which have the best chance, in the opinion of those scientists and engineers who are capable, are the ones that should be first developed for economical and competitive plants.

Now, in my opinion, we have made wonderful progress in the 2 years since the Atomic Energy Act was opened up for industry participation. I think we have made wonderful progress. In famt, I think that the electric industry, both manufacturers and utilities, has made more progress in this particular effort, in the 2 years we have been at it than any other research and development work that has been done by the industry in its 75 years of existence.

Chairman ANDERSON. All right. I still think that you depend a little bit upon some of the research that has been done by the Government.

Mr. OAKES. Of course we do.

Chairman ANDERSON. And I think we are still dependent to some extent upon it and I think also some of those individuals who worked up some of these Government programs which industry is now adapting believe that there are strong possibilities of useful knowledge being gained from the development of some of these other types which industry is thus far unwilling to consider. They might make a demonstration that could change this whole picture. I illustrated a day or two ago, when you were not here, that we decided to develop the hydrogen bomb in a particular fashion. All of the plans were laid to develop it in that way, and it was the only way, we thought, that it could be done. Accidentally, almost, in some test, we found that there was another way, and no one understands exactly why, but that way worked better than the path we had. We could say, "Well, it could not work, the scientists did not think it was going to work and the engineers did not think it was going to work and it just could not possibly be that way." But it was. Now, it might be that what Dr. Zinn suggested about taking the Hanford-type reactor and making some changes in it which he outlined might work. Dr. Zinn had a lot to do with the Savannah River reactor, if he did not design it and so forth. He thinks there might be something that could be developed down there that might be worthwhile. He thinks we ought not to overlook this bet on gas power. There might be nothing there but there is a possibility that it could. For the life of me, I have trouble understanding the position of the industry that says, "No, the only types that are any good are the ones that we have picked up."

Mr. OAKES. I do not think that this is quite true, Senator. Yesterday it was announced here there was a new type or another type to be developed by the Florida group, added to the types already announced That, in my opinion, is direct evidence that we are looking around for different types. We are not concentrating on any one type.

Chairman ANDERSON. How far along do you understand the Florida group to be?

Mr. OAKES. They are just starting.

Chairman ANDERSON. Was the announcement a firm announcement, would you think?

Mr. OAKES. I understood it to be so. I did not hear the evidence and I was not here, but I have had the newspaper account of it.

Chairman ANDERSON. I do not wish to speak disparagingly of the Florida people, I was happy they were here, and I was glad they made their annunocement, but it is a pretty nebulous announcement. There is no choice of types, and no announcement of what they are to do, and they hope to be able to consider a possibility of getting started at some time. I am happy they do, but if we are going to depend for our kilowatt race with Russia on the possibility that at some later date somebody will come in with a project in Florida that may test out a type that has not been tested out, I think that we will let Russia take over every European and Latin American market and nullify the expenditure of about $50 billion worth of foreign aid.

Now, if that is the price we have to pay for reactor development in the United States, it is a pretty stiff price.

Mr. OAKES. Later on in my testimony, I think that I have an answer to the question you just raised here. You can depend upon this industry and the manufacturing industry to keep on searching to find a salable article at the lowest operating cost, which is really the competitive advantage that you will need in all sales, whether national or international.

Chairman ANDERSON. I think I agree with you. We can depend upon them to keep on searching. In the meantime, Russia is building. I would hope we might build also. I do not think that the Russians believe that these plants that they are now building are the last word in human wisdom or necessarily the final style. We have been dealing with some accelerators here in the last few days, in the discussions, and the point was brought out that Russia does have better accelerators than we do, bigger capacity than we have. They realize it might be possible 100 years from now to devise something better but the news stories quoted the scientists in America that they were bowled over, I believe the expression was, of Senator Pastore, by what Russia did.

I attended the high energy nuclear physicists conference at Rochester. They tolerated me. The rest of them understood what they were talking about, and I did not. They were kind enough to let me visit with them one evening and make a speech. But just beyond me was the great Russian scientist Vechler, and beyond him was Dr. McMillan. He had designed cyclotrons. They both thought that they had invented the art, practically, of what they were doing. They found out that simultaneously they had developed these things.

I think until Professor McMillan talked with Vexler, he really believed that Russia had copied us, but he did not believe it when he got through. I do not know whether we dare believe that they are incapable of producing these things or not, but they are going to keep building them right along. When we get our next one finished, our biggest accelerator finished, and we will be proud of it, at Brookhaven, it will still be inferior to what Russia will have completed by that time.

Now, that is one of the races in which we are behind. I do not think we know the importance of strange particles, but they might have some important significance in this race. I am just hoping we do not let them get ahead. I ought to let you get ahead with your statement, I realize that.

Senator GORE. Could I ask one question there?

Mr. Oakes, you say that we can depend upon the industry you represent to keep trying. I am glad that you will keep trying. I do not castigate the utility industry for what it has done in trying to develop this field. I hope it will try harder. Why do you think that the country should depend solely upon the private utility industry for the development of a national resource, the development of which involves the national interest.

Mr. OAKES. We have not depended entirely on the industry to date. This comes out of research made by the AEC, started, of course, in the defense program. That research has moved over into the power program.

Senator GORE. Do you think that if the country had depended upon the private utility industry to develop the Columbia River that we would now have the great hydroelectric development in that basin?

Mr. OAKES. I think that if the Government had not moved in on the program, you would have had the Columbia River development developed by private industry, yes, sir. I think that was an outright invasion of private industry.

Chairman ANDERSON. I was out in that area, as FERA Administrator. I wish you could have been up there when we started putting the first truckloads of dirt down in the Columbia River and heard what private industry had to say about the possibility of a dam.

Mr. OAKES. I am an Oregonian myself, and I know the country pretty well, too.

Chairman ANDERSON. Talk to General Robbins sometime, who was then Colonel Robbins. He was our engineer then at Portland. He had to fight off the wolves when he started. That is a matter of private opinion.

Senator GORE. I welcome whatever contribution your industry can make and will make in this field. I want to facilitate your more enthusiastic participation, but I do not think in all fairness to the national interest that the Government's hands should be tied in order to protect the interest of this private group.

Mr. OAKES. We are not asking that the Government's hands be tied in anything.

Senator GORE. You are asking that the Government not construct any power reactors, is that not tying the Government's hands to that extent?

Mr. OAKES. Of course, I am saying that there is no need of the Government undertaking this program. All you are doing——

Senator GORE. Suppose that there is a need, and suppose the Congress considers that there is a need, do you still oppose it?

Mr. OAKES. Of course, that is opinion and judgment. It is my opinion and my judgment that there is no need of Congress undertaking this program at this time. It will merely divert brainpower from the present program.

Senator GORE. Now, what particular competence does the electric utility industry have in nuclear physics? Has your company ever constructed a reactor of any size or any sort?

Mr. OAKES. We are undertaking to do that now.

Senator GORE. I am speaking of the past. Have you had any past experience in that?

Mr. OAKES. No, sir.

Senator GORE. Has the Government called you in?

Mr. OAKES. We are now undertaking one, at the present time.

Senator GORE. Have you had any contract with the Atomic Energy Commission to participate in the construction or operation of one?

Mr. OAKES. Now, let us just review a little history. Your question is not, I think, apropos.

Senator GORE. Let me decide whether it is apropos. You decide how you want to answer it.

Mr. OAKES. I beg your pardon.

Senator GORE. I will let you answer it any way you like.

Mr. OAKES. Let me refer to the history of this industry. This industry depends upon manufacturers for the supply of its component parts.

Senator GORE. In other words, your company has never even constructed a generator, let alone a reactor?

Mr. OAKES. Of course not, we depend upon manufacturers.

Senator GORE. Of course.

Mr. OAKES. But we have had research and we have spent many, many thousands and hundreds of thousands of dollars on research with manufacturers, and asking manufacturers, as a result of that research to build certain equipment the way we would like to have it built. We were the company that undertook, first, to develop the traveling stoker. The result of that was that the traveling stoker industry was taken over by the manufacturers and developed and used.

Now, this industry is not a manufacturing industry, of course, Therefore, why should we build the reactor? We depend upon the manufacturers to build reactors.

Senator GORE. But you are asking the Government to depend upon you and the industry you represent for the development of the reactor program. Now, you say my proposal would divert brainpower. From what you have said, no matter how vigorous a program we might have, it would not divert brainpower from the utility industry, because you have demonstrated no particular competence in this field. I do not say that critically, but I just say it as a matter of fact, from your statement. Now, you say, to go further on—do you know if any of the concerns who have presented proposals have contracted with the Dupont Co. to build its reactor?

Mr. OAKES. I do not know.

Senator GORE. Do you know of any use to which the great experience of the Dupont Co. in constructing the Savannah River reactors is now being put to use?

Mr. OAKES. I know of none. I cannot answer the question, I do not know. You will have to ask the Dupont Co.

Senator GORE. Then your statement is general.

Mr. OAKES. My statement is general, of course. What I am saying is that in the construction of power reactors over and above those in the present program as proposed in S. 2725, we would be diverting brainpower from the present program, and duplicating the present program thereby spreading the available brainpower over a greater number of projects. This, in my opinion, will not advance the art.

Senator GORE. I in no way desire to be unpleasant with you. What I am trying to illustrate is my deep concern over the slowness of the present program. There are roadblocks in the present program. There is inability to get ahead under the present program. You say that you think the progress is marvelous and fine.

Mr. OAKES. Yes; I do.

Senator GORE. I think it is dangerously small and slow. Now, you are entitled to your opinion, and I am entitled to mine. You are president of a private utility and I am a Member of the United States Senate. You have a public responsibility as a citizen, and I have it as a citizen but as a Member of the United States Senate I have a greater public responsibility. I think that you would agree with that.

Mr. OAKES. You probably have; yes, sir.

Senator GORE. Is that not as it should be? That is what we elect officials for, and that is why we have a United States Congress.

Mr. OAKES. Yes; probably you are right.

Senator GORE. Thank you very much.

Chairman ANDERSON. I want you to get on with your statement, but I do want to get the Florida reference of yours into what I might regard as a proper context. To your mind, it is an evidence of how private industry is moving ahead. To my mind it is an evidence of what the Government has had to do to help private industry move ahead. Now, the Brookhaven Laboratory has developed a bismuth-type cooler and the Brookhaven Laboratory or the Government, AEC, has just entered into a contract with Babcock & Wilcox to try to build a small pilot plant testing that principle. Babcock & Wilcox have signed up with Allis-Chalmers jointly with the Florida group to help them design whatever they are going to have, and they have said to the Florida group, "If this bismuth-type color which we are going to build for Brookhaven works out, it might be something that you would like to look at."

That is as far as the Florida group has gone, I believe, in the selection of its type, and the contribution it has made to the industry. If the Florida people can supply you with something other than that, I would be happy to have you put it in the record, but certainly that illustrates the fact that if there is a new type, Government money is going to have to start in to develop it and it is doing it now. That is, with this contract by Babcock & Wilcox in Brookhaven.

Mr. OAKES. I appreciate that.

Chairman ANDERSON. That is all we hope to do, and after it is done and it is a finished thing, I will be happy if a dozen private utilities pick it up and use it in the generation of current because that will help us keep abreast of our responsibilities worldwide.

Senator GORE. Well, Mr. Chairman, is that not the very aim of what we are undertaking here?

Chairman ANDERSON. Precisely.

Senator GORE. Had it not been for the Government's efforts thus far, this gentleman's company would not be proposing to build one, and if the Government will redouble its efforts then the number of private concerns making proposals to the Government may be quadrupled or more, multiplied even more, and that is the aim. I have never envisioned the purpose of the bill that I have introduced to harm the utility industry, or to deter its entrance into this field. It is to invite it and to encourage it and to prove the feasibility and provide the examples. It is because the Government has provided the examples that you desire to enter it now. I just cannot quite see why the utility industry wants to forestall the Government from further development in this field. I know of no part of our economy other than the whole people that would so benefit from further development in this field. You have just said, Mr. Oakes, that the utility industry needs, and you have been searching and you have been hoping for some new method of generating power for the future to meet the tremendous demands that are ahead. Could it possibly be a narrow point of view that the Government should not pioneer further in this field.

Chairman ANDERSON. I think the record ought to show, for Mr. Oakes' sake, that we are not trying to pick on him here this morning, much as it may sound that way. We recognize that your company progressively tried to participate in this Shippingport demonstration but was outbid by some other group, but your whole attitude in it was a fine attitude that deserves commendation. When you did not get the Shippingport job, you applied for an access permit and you are now trying to go ahead with an advanced style of reactor. For that we want to give you full credit, and therefore I would hope to offset some of the earlier questions by that statement in the record at this point.

Mr. OAKES. Of course, the Government has done a remarkably fine research job in this power reactor field. No one questions it. Every advantage ought to be taken of that research. But when we are advanced to the point where this research results in a commercially feasible power reactor of large size, then the Government ought to step out of the field and let private industry take it over.

Senator GORE. But it has not done that.

Mr. OAKES. Oh, yes, industry has, it is moving just as fast as it can.

Chairman ANDERSON. That is the very thing that appeals to me in the suggestion that has been made about the construction of these reactors. I do not believe that if we took the suggestion that was made and tried the Hanford type reactor or the Savannah type reactor or gas-cooled reactor, that it would be immediately commercially possible or commercially feasible. As far as I am concerned, I am willing to fight out the battle as to whether any of this is handled in any way except by private utilities when we have made them commercially attractive. They will not be attractive now. These first reactors that will be built, even under the Gore bill, will probably produce electricity that is going to cost a whole lot more than it ought to cost in order to be competitive with other conventional fuels. The idea is not to set the Government up into business in generating electricity for sale.

Mr. OAKES. That may not be the idea, Senator, but in my opinion that will be the result, and that, I will say, I abhor.

Chairman ANDERSON. I think that you are worried that the Government is going to get in the generating business.

Mr. OAKES. Of course I am.

Chairman ANDERSON. On that theory, we should never have investigated the construction of a powerplant for a merchant vessel. We are about to authorize it, and we ought to quit it and let the industry do it.

Mr. OAKES. Oh, no.

Chairman ANDERSON. The Government might get in the shipping business that way and just ruin everything.

Mr. OAKES. Now, let us get first things first here.

Chairman ANDERSON. That is just exactly what you have been saying.

Mr. OAKES. Oh, no.

Chairman ANDERSON. You are against a reactor because it might get the Government in the business of generating power and you ought to be against a nuclear-powered merchant ship because the Government might get in the shipping business.

Mr. OAKES. Now, Senator——

Chairman ANDERSON. All right.

Mr. OAKES. I said at the start in my statement, that if this industry is willing to continue in the business and use every facility and new invention that will result in its lowering its cost of production, eventually, and not at the beginning, we should be allowed to do so. I say we will undertake it, and that we propose to do it. That is why my company is doing it. We will be spending several million dollars in this in research work. We do not have to spend it, we could let somebody else do it or let the Government do it. I do not think that that is good policy for any industry.

Chairman ANDERSON. You go ahead with your statement and let me reassure you that this bill may not be quite so close to Government generation of current as you believe.

Mr. OAKES. I believe there is no record of this ever happening—and this is a continuation of the testimony—because it has never been felt by the Congress that any such action would be a proper action for Government to take.

Yet, in substance, it is just this kind of a take-over which is inherent in the program proposed by S. 2725. One can readily see that a possible end result for the long term is preemption by Government of all power generation by nuclear means. And in time, as we all appreciate, nuclear power will become the prime source of electric generation.

I do not doubt that if the Gore bill program is carried out—and regardless of whether or not the same types of reactor are developed and constructed by industry—that public power proponents in the future will raise the cry of "give away" if the electric utility industry thereafter undertakes to construct improved power reactors of the type built under authority of S. 2725. Also, I expect that the Gore bill program will be used by some, at least, to tie in with the preference clause provisionss of the Atomic Energy Act, and thus be directed to a great extension of tax-subsidized public power.

In brief, in considering the program of S. 2725, I suggest that it would be very wise to take a careful look at where that program may lead. In my opinion, S. 2725 is a significant step toward blocking the normal future growth of the electric industry through preemption by Government of the nuclear power field and interposition of the insurmountable barrier of tax-free Government power. My opinion in this respect is fortified by the enthusiastic endorsement of S. 2725 by well-known public-power advocates.

Upon reflection and consideration of all the facts, I think you will agree that it is contrary to the national interest to embark upon a program of Government intervention which will have the effect of maiming the electric utility industry.

Our industry has an outstanding record of meeting all power demands. In World War II and in the Korean war all of the great defense power needs of the country were fully met. Huge expansion programs are under way today to insure that there will be adequate power in the event of further emergency conditions. All of this has been done while achieving an unequaled record of low cost for electricity, in sharp contrast with the greatly increased prices of all other materials, products, and services. Nowhere in the world is electric

power so plentiful, so reliable, and so cheap as in the United States. This is not the kind of record which justifies a Government takeover.

It is worth considering also that the great expansion of the electric utility industry in the postwar period has been mainly accomplished through the sale of securities to the American public. For the period 1946–55 the aggregate amount of such securities so sold, all representing new money, was $13.4 billion. Including securities sold for refunding purposes, the total amount is $16.8 billion. Obviously this great amount does not represent the holdings of a few stockholders. It represents the direct individual holdings of millions of American citizens, as well as very large institutional investments which underlie, and support the payment of, insurance policies, pensions, hospitalization plans and sick-pay plans, and the like, all affecting many more millions of American citizens.

If the Gore bill, or any counterpart, is used to block off the normal future growth of the electric utility industry, you will surely have a "sick industry" in time. Any such result will inevitably have a substantial devaluing effect insofar as the securities of the industry are concerned. And who bears the risk of loss? The millions of investors and the many millions of other persons who, through pension funds, life insurance funds, and the like, are adversely affected if utility earnings are impaired or utility securities do not maintain their value. I cannot conceive that there are any gains from a takeover by Government in the nuclear power field which would offset substantial losses to such persons.

It will be recalled that one of the stated purposes of the Atomic Energy Act of 1954 was to "encourage widespread participation in the development and utilization of atomic energy for peaceful purposes." This philosophy is certainly not being carried out under the terms of S. 2725. Actually S. 2725 is the very antithesis of an encouragement to industry to participate in the atomic field.

Furthermore the Panel on Impact of the Peaceful Uses of Atomic Energy just recently rendered its report to the Joint Committee. It was the conclusion of the panel on the particular point here in issue, stated in chapter 2 of the report, that:

> Private enterprise should carry a substantial part of this research and development program, including especially the construction of full-scale "demonstration" plants.

Chairman ANDERSON. I do not have the report in front of me, but do you not remember what followed there? It said, however, if private industry does not, what ought to happen, in the panel's opinion?

Mr. OAKES. Of course, the Government is going to do it.

Chairman ANDERSON. That was signed by such flaming New Dealers as Ernest Breech and Frank Folsom. They recognized that if this industry is going to be any good, it has to advance. Mr. Oakes, I had a grandfather who was in the ice business, cutting ice out of the river and selling it to the people in the town. His securities would not be any good at all now. Somebody came along with a little copper wire and just destroyed his business. If we do not stay abreast of what is going on in the world, pretty soon you do not have any business, and if we let Russia take all of the fields away from us, in every other country, and let the British and the French and the Russians manufacture the equipment that goes into every one of those places for the

generation of nuclear energy, I do not think that it is any great help to the electric industry of America. I really do not.

Mr. OAKES. In my opinion we are not going to do that, sir.

Chairman ANDERSON. You are if you can get away with what is now being proposed, that we sit idly by and let Russia develop.

Mr. OAKES. I cannot take that interpretation at all on this program that we are undertaking.

Chairman ANDERSON. You are worried about this generation of public power.

Mr. OAKES. Yes, I am; certainly I am.

Chairman ANDERSON. If you will just let your fear of that get away from you for awhile and take a look at what is going on in the world, Russia is building plants whether we like it or not. Britain is putting plants on the line whether we like it or not. France is starting to develop. The Belgians did not buy that reactor the other day in order to examine it and look at it like a piece of decoration on the wall. They are a manufacturing country too, and they are going to be in the business of developing.

Mr. OAKES. But the race is going to be run and won by the manufacturers in this industry who develop the reactor that has a low cost of operation.

Chairman ANDERSON. Precisely.

Mr. OAKES. And that is going to determine in the long run who is going to sell them.

Chairman ANDERSON. Precisely, and you will learn how to do it by building plants and testing and discarding and testing and discarding, the trial and error method, and the very thing you did when you built your stoker.

Mr. OAKES. That is right, sir; and I think the manufacturing industry and utility industry are going to do just that, and produce that experience for you.

Senator GORE. Could I ask one question there? Can you possibly envision an injury to your industry by the Government constructing a large-scale reactor, not in duplication of one which your company or any other utility company has built, but of a different design, to furnish power to the Atomic Energy Commission itself at its Hanford, Wash., works?

Mr. OAKES. For that particular installation, no; but that is not proposed here. You are proposing to put them all over the country and where can you put them? You cannot possibly put them at any location not already being supplied, and fully supplied, with electricity today, because the whole country is now supplied.

Senator GORE. Is that the reason you oppose it?

Mr. OAKES. I oppose it for that reason and I say that the utility industry can do this job. It does not have to be done by the Government.

Chairman ANDERSON. If the country is adequately supplied, why do we give fast tax write-offs because the country is not properly supplied?

The industry comes in and asks for fast tax writeoffs because they need this generating capacity because the country is not supplied. Do you recommend we stop that at once? You have said the country is adequately supplied.

Mr. OAKES. I am saying to you, Senator, that this country has an adequate supply of electricity today, and that our program for installation of new generation to take care of growing demands has been planned in every section of the country.

Chairman ANDERSON. Why is it the administration tried to shove the Dixon-Yates deal down our throats? If there was enough, why do we get Dixon-Yates?

Mr. OAKES. Because private industry should have taken that job and not Government power.

Chairman ANDERSON. Because we were short of power, unless we misunderstood it. I understood it was because we were going to be short of power somewhere in the country.

Mr. OAKES. Shortage of power is only temporary, and shortage of power is a question of whether OVEC or someone else is going to build the capacity. It should not be a question of whether Government or private industry has to install the proper generating facility. The utility industry can do the job just as fast and just as quickly as the Government in any location.

Chairman ANDERSON. I see. You have misread some of the signs along the highway, because OVEC—and I do not use this improperly—but it was the Democratic Party's answer on how to get this current, built by private industry, and so was Electrical Energy, Inc.

Now if private industry wants to walk up and do something of that nature in connection with these plants, I would be happy. I would like to see somebody come along and say, "We will take our technical know-how, and our great experience and we will take one of these types that has thus far not been suggested and we will build it. I would not mind the Government putting up a good deal of the money to build the nuclear part of it, and private industry putting up the generating part just as Shippingport.

But that shocks people, to have that revolutionary approach. It does not shock me, because I believe in the approach that we used at OVEC and I thought it was very good.

Mr. OAKES. I do, too.

Chairman ANDERSON. The plants have been constructed and the report is finished, and I believe two or three hundred million dollars was saved under the preliminary estimates for the construction of that plant.

Mr. OAKES. That is correct.

Chairman ANDERSON. What was wrong with it?

Mr. OAKES. Not a thing.

Chairman ANDERSON. Why are you so fearful it should happen again?

Mr. OAKES. I do not fear that it will happen again, that was done by private industry. I am saying to you that private industry can provide the power requirements at any place in this country.

Chairman ANDERSON. Well, private industry had to have the Government guarantee before it would build it, and no private group would supply one kilowatt of power for that place.

Mr. OAKES. Of course, that was a deal between the Government and private industry, and it was a very excellent deal for both.

Chairman ANDERSON. I think so, too. But bear in mind, and never let the record be forgotten, that the Atomic Energy Commission could

not get from anybody an offer to supply current to the Paducah plants unless it guaranteed the purchase so it would retire every bit of indebtedness against those plants. That is not completely private, but it worked out fine. We were all for it. Some of us would have liked to have seen that tried instead of the Dixon-Yates idea, but that is another story.

But now, I cannot understand why it would be wrong to build some of these plants around the country. I think that you misread the Gore bill. I do not think the Gore bill is a bill to put the Government in the generating business forever and ever and ever. But we would like to jump a few of these hurdles that now exist and get some plants in operation and learn by doing just as we have done for 150 years or more in this country.

Mr. OAKES. The utility industry has been learning by doing for many, many years, and it is succeeding in doing a remarkably fine job in my opinion, and we are willing to undertake this, and in my opinion we are doing so.

All consideration of possible special programs of Government spending to finance such demonstration plants was subject to the condition that such plants would not otherwise be built. As has been pointed out, full programs of development and construction are now under way. Thus, the Gore bill is not justified within the terms of the panel's recommendations.

All that I have said up to this point has been directed to the relationship which exists, as I see it, between S. 2725 and the electric utility industry within the United States. But there is, I recognize, another aspect of the Gore bill which has been the subject of considerable discussion, namely, that "acceleration" is necessary because of conditions at the international level, particularly the so-called race with Russia and to some extent with England for the development of practicable power reactors.

I certainly do not appear here as an expert on foreign policy of the United States nor as an expert of the comparative status of the development of nuclear art here in this country and in England and in Russia. I do point out, however, that if S. 2725 were essential because of international and foreign policy aspects, one would rather expect an official representation to be made to this effect by a qualified spokesman from the Department of State. To my knowledge, no such representation has been made to this committee, or by the Secretary of State to anyone.

Chairman ANDERSON. Let me say there, that if you had written a letter to the Administration asking them to insist that the Joint Committee on Atomic Energy make public the hearings of last Tuesday, we would all appreciate it very much. You might find out what the official attitude of this Government can be on this question. It cannot be made public, but it would be interesting if it could be.

Mr. OAKES. Insofar as the comparative status of the nuclear art is concerned, it is my understanding from the testimony of Admiral Strauss, Mr. Sporn, Mr. McCune, Mr. Weaver, and others, that we are doing right well in this respect and that there is no need for a crash program to be superimposed upon the existing programs, since these existing programs cover the field and are now being aggressively carried forward.

On the subject of acceleration, my consideration of this matter has led me to the conclusion that the quick spending of several hundred million dollars, or as has been mentioned $1 billion, to carry out a program along the lines of the Gore bill, will not achieve the kind of acceleration which this committee is apparently interested in accomplishing.

Perhaps we had better define our terms a little—there is a natural tendency when using such language as a "race" with England and Russia in the field of nuclear power development, and in talking of acceleration of programs in this country in this context, to think that we are dealing with a contest which, like a track event, is going to be resolved within a measured distance. It is very easy to fall into the habit of thinking of the situation as one where the so-called winner will be the nation which first places in service a technically sound nuclear power reactor or first places in service a power reactor which gives a favorable cost of power in mills per kilowatt hour.

I think you gentlemen will agree that the problem is not so simple. We all know that the first nation to create a jet aircraft did not thereby obtain controlling power in the skies of the world, although there was a tendency to think that such would be the case when the jet was in development.

Chairman ANDERSON. Who do you think has the most jet aircraft in the skies?

Mr. OAKES. In the skies today? Well, the newspapers say that Russia has, but I do not know.

Chairman ANDERSON. So does our Government, officially. If you doubt that get the testimony of General Twining, and get the testimony of Curt LeMay, and get them all.

Mr. OAKES. I appreciate that.

We have all come to appreciate that insofar as jet aircraft are concerned, it is a matter of long-term contest to see who will have the best technology today and tomorrow and the next day. It is a continuing problem of creating an everimproving technology. We certainly have seen the same thing happen in the case of the atomic bomb itself. The first nation to have the bomb did not for long have the upper hand in the technological field. There again it has become a matter of a continuing drive to achieve an everimproving technology.

Chairman ANDERSON. Coud I ask you a question on this foreign question? This is a hard one to get to, and I am not questioning what you have said about the fact that nobody has testified, but the report which was made on the 5-year power reactor development program related to the pressurized-water reactor, and said this:

> The pressurized-water reactor might also contribute substantially to carrying out the President's International Cooperation proposal. It uses as fuel uranium slightly enriched in the isotope 235.

This is what I hope you will hear:

> With relatively minor redesign, it would operate on natural uranium if heavy water were to be used as a coolant and moderator instead of natural water. Plants of this type could be built in foreign countries with the United States' assistance, at an earlier date than the more novel plants used in highly enriched fuels. Thus we believe electric power could be provided at competitive prices in many parts of the world during the next 10 years.

Now, that is the sort of thing that is envisioned by the Gore bill. We would like to take what is now being done and try to develop a

different type of fueling, that is, using natural uranium and heavy water, and nobody, so far as I know, is doing that at the present time.

Mr. OAKES. I think that that is right, and I know of nobody doing that.

Chairman ANDERSON. That is all we are trying to say. There are some other sides to this question besides the fear of public generation of power by the Government.

Mr. OAKES. We believe the same considerations exist insofar as nuclear power reactors are concerned. The first nation to put a power reactor in service, or to achieve a certain record of reliability or cost, does not thereby spread-eagle the field. If the viewpoint of the neutral world is important, we can be realistic and say that they know as well as we do that the ultimate lead nation in the power reactor field will be that nation which establishes an ability to maintain an everimproving technology over a continuing period of time.

All our experience most strongly suggests that at this juncture the spending of money will not ensure winning the race with Russia. The critical element in the situation is not money. It is brain power. Testimony to this fact can be found almost anywhere you wish to look.

As Admiral Radford, the Chairman of the Joint Chiefs of Staff, stated in the recent hearings before the subcommittee of the House Appropriations Committee, the critical factor is not money but the availability of the people who have the brainpower to solve the technological problems that have to be met:

> Thus we have the question in some research and development fields as to whether or not we might be spending too much. I have come to the conclusion that we are spending probably all of the money in research and development that we can spend to advantage. We have reached a stage where the limitation in that field is probably a matter of competent scientific personnel available for that work.
>
> We can give a contract to a company for a research program and usually they will take it. Then we see ads in the paper where they try to hire trained men away from some other company which is producing on some other defense research program. There is the shortage. If we were to materially increase our effort in this line I think we would cause trouble (hearings, subcommittee of the House Appropriations Committee, Department of Defense appropriations for 1957, April 18, 1956, p. 12).

Admiral Radford's statement provides a fair picture of the difficulties that would be caused by enactment of S. 2725.

As another recent example, on Monday of this week the New York Times carried the story of the report made by the California Institute of Technology, following an extensive analysis by their faculty, of the future potential of this country. The conclusion of the report is that a fabulous future lies before us for which the keynote will be a vastly improved and enlarged technology.

But the report points out that realization of that future potential hinges on meeting the country's critical need for more brainpower. In an appendix to this statement, there is collected a substantial part of the current comments on this question of brainpower.

In total, the California report and the many comments of educators and spokesmen for Government and industry do no more than confirm the report on engineering and scientific manpower in the United States, Western Europe, and Soviet Russia, prepared under the direction of Mr. Price as chairman of this committee's subcommittee on Research and Development.

From Mr. Price's report, I think it is entirely clear that if it is decided that large amounts of Federal funds should be committed to a program of "acceleration," then such funds will be best utilized in the field of what Mr. Price has referred to as "the life and death field of competititon in the education and training of adequate numbers of scientists, engineers and technicians."

In conclusion, I should like to leave with the members of the committee one final thought. Our industry is performing an important role in the job of developing electric power by nuclear means. We know that unless we do our part fully and well, then the job will be done by others, and let me emphasize that. You may be sure that we are aware of this state of affairs, and, for this reason, we have a most compelling incentive to carry out effective programs for the development and construction of power reactors. Again, I want to emphasize that fact.

Chairman ANDERSON. I think that we interrupted you so much that probably we should not have additional questions at this time. I do appreciate your coming down, and I do hope that there might be, Mr. Oakes, a realization that we would like to see this program operated and under way, and if there are some things that are apparently stumbling blocks to this as you see it, maybe you could point out to us what they are as the industry has pointed out the insurance problem and perhaps we can do something about it. It is not my thought that we use the Gore bill as a device to set the Government up in the business of trying to generate current in competition with your firm and the other firms. I am hoping that we can make progress in this country as compared to the rate of progress in other countries.

Mr. OAKES. I appreciate that comment, sir; and I want to assure you that this industry, the public utility industry, is extremely desirous of making the most rapid progress in this field that can be made.

Thank you very much.

Chairman ANDERSON. Mr. Swisher is the next witness.

STATEMENT OF ELWOOD D. SWISHER, VICE PRESIDENT OF THE OIL, CHEMICAL, AND ATOMIC WORKERS INTERNATIONAL UNION, AFL–CIO

Mr. SWISHER. Mr. Chairman and gentlemen of the committee, my name is Elwood D. Swisher, and my home is in Denver, Colo. I am vice president and coordinator of atomic affairs for the Oil, Chemical and Atomic Workers International Union, AFL–CIO.

Our union represents a substantial number of workers employed in atomic energy establishments. We represent all the production and maintenance workers in the gaseous diffusion establishments in this country. Our members operate the testing reactors at Arco Blackfoot, operated by the Phillips Petroleum Co. The work and activities of these locals are coordinated through the Atomic Energy Workers Council of the OCAW of which I am the coordinator.

I appreciate this opportunity to appear here again in behalf of the Gore bill, S. 2725. I said I appear here again because I had the pleasure of appearing before you a number of times before, including the appearance on July 22, 1953, at which time I called the attention

of the committee to a proposal along the lines now pending before you as the Gore bill. I said, p. 501 of the hearings:

> No better program for increasing the benefits from atomic energy, nor for reducing the cost of (the AEC plant) operations could be arranged than for the AEC to build power-producing reactors to meet part of their own power need.

Mr. Chairman, it is that possibility which we are here considering today and I want to take this opportunity to commend Senator Gore and Congressman Holifield for introducing the bills which will make possible the implementation of that idea. I said back then that I never understood why the program for power production which had been started in Oak Ridge for the construction of the Daniel's pile was canceled in 1950. I understand now more clearly that there has been a determined effort to prevent success of power production from atomic energy until the private utility industry could find it profitable. This understanding has been substantiated by two recent statements. The first by Alvin Weinberg which was referred to here by Mr. William Schnitzler is:

> * * * at the moment the economic incentives to go into large-scale power reactor development are not sufficiently apparent to make such development a really good short-term bet.

The second is the Wall Street Journal of May 10, 1956, which quotes an industry man as saying:

> It's no secret, for example, that many private utilities are investing in atomic powerplants to forestall development of "atomic TVA's" across the Nation.

At Oak Ridge, Hanford, Los Alamos, Paducah, and Portsmouth, it would be possible to build reactors, use them to meet part of the power needs of the AEC itself. These needs are growing by leaps and bounds. As appendix A I am attaching tables showing the increase in electric power needs, and I call your attention to the fact that in the 1 year from 1955 to 1956, the use of electric power at major AEC installations had increased by a total of 20 billion kilowatt-hours, so that AEC consumption of electric power this year will constitute 12.8 percent of the total consumption of electricity in the entire United States. Six reactors producing a total of 600,000 kilowatts would supply only part of this power need.

I might add that as of the total that would be roughly just short of 10-percent savings in that much power to be consumed this year. It would make possible the development of experience and know-how in the atomic power field which is so essential for the advancement of the art and the advancement of our know-how which the situation requires. In 1953 I pointed out, and I quote:

> Likewise in the Hanford plant, production of some of its electric power needs directly by the AEC would make available to that expanding region portions of public power now used by the Commission. Every argument for the earliest completion of this power program seems to require that it be achieved by direct Government completion of at least the first power reactor.

I support the position taken by Senator Morse. The reactors in Hanford which are about to be rebuilt could be rebuilt as dual purpose reactors, and instead of heating the Columbia River we could provide some additional electricity to the power-short Northwest. The hearings on the authorizing legislation held this past February indicate likewise that there is a power shortage at Los Alamos, and the Con-

gress has just voted to provide, under item 57–f–4, for the installation of a 115-kilovolt tie line. Testifying for the AEC, Mr. Fields said:

> We find that this (our power demand) is going to go up substantially in the next few years as a result of the installation of the new laboratory and the new sigma building that you authorized last year, as well as certain experimental requirements. So we will have a requirement for something like 29,000 kilowatts by 1958.

I have spoken publicly about this point. As a result, Mr. Chairman, all the claims that we are short of skilled manpower are unfounded. After all, we started this whole project without any skilled workers. We trained the workers as well as built the plants in less time than industry now claims it is necessary to delay. I cannot agree with the pessimistic forecasts of those spokesmen for the private utility interests who say hat the real need for developing electricity from atomic fission will not come in the United States for 15 or maybe 25 years. The need for power lies immediately ahead of us and I endorse the position taken by Mr. Schnitzler here yesterday, that the need for political and international considerations are overriding and must be given primary consideration.

Mr. Chairman, one aspect of the opposition to this bill is incomprehensible to me. I refer to the criticism of this bill because of some alleged impact of the preference clause on the power which would be produced. Our organization has supported the preference clause as it relates to power produced by Federal hydroelectric and other projects. But this issue need not be involved in the bill which is before us in my opinion. If the atomic reactor for power were built in New England, say Rhode Island, for example, there are no REA's or municipally owned plants which could apply for the surplus power, and if the reactors are built in the existing atomic installations as I have suggested, there would be no surplus as the installations need many times more than the total amount which could be available from these reactors. Nor is this issue one of public versus private power. As a matter of fact, in my opinion the private-power industry will be one of the main beneficiaries of this program when the technical success of power from nuclear fission is made available to all.

Part of this increased requirement likewise could be met by the construction of a reactor under the Gore bill.

There is another advantage which can be gained from the construction of power reactors at some of the existing AEC installations. These communities already have a large body of trained workers. We, in the industry, do not feel that the only source of technical workers are the colleges and universities. During World War II we proved that many skilled workers can be upgraded and trained on the job so that our present supply of manpower can provide a major portion of the workers who would be needed to build these new reactors.

Some firms have been syphoning away skilled workers from these communities who are sitting around in offices of private enterprise who intend some day in the future to participate in developing the atomic energy industry, but whose talents and skills are going to waste today. Our members, the workers in the plants, see the constant technological improvements that are being made. The increase in efficiency is making it possible to reduce the number of man-hours for each unit of production.

We are interested in a prosperous America above all. This applies to all of labor. In the chemical industry and the atomic industry, we are interested in a prosperous America and we are specifically interested in a good supply of electric power, which is one of the major raw materials of our industry.

The Government must do this because industry alone is not getting the job done that needs to be done. By its very nature, investor financed industry must proceed with some caution and with deference to the interests of its financial position. Giving private industry every benefit of the doubt, and for that purpose conceding that competitive electric power development from atomic energy on a substantial scale is far in the future—farther in the future than will be the case if both private and public experimentation are not carried on simultaneously and promptly—enactment of the Gore bill will be an aid to the private-investor financed utility industry.

The Government must take the action contemplated in S. 2725 in order to protect its position of prestige and respect in the world. Recently, the world has been treated to many newspaper headlines about the argument raging within our Government as to whether this Nation or Russia is ahead in the arms race—the race to build faster planes with longer range to carry more and larger bombs around the world. How much better it would be for the United States to be recognized worldwide as the leader in a race to develop peaceful uses of the atom.

The members of the committee have more access to, and more knowledge of this program than I have, but I was privileged to represent the International Confederation of Free Trade Unions at the U. N. Conference in Geneva last August and while there I had the opportunity to see the exhibits and talk to other labor representatives and scientists from all parts of the world. That conference raised the hopes of all who participated, of the possibilities for a higher standard of living which lie ahead.

I was impressed by the quality of the exhibits from each and every country including the exhibit from behind the Iron Curtain. Since returning I have had an opportunity to review the proceedings of that conference and I call your attention to the extensive technical detail on power reactors which is printed in volume 3 of the proceedings by the United Nations and available throughout the world.

On page 35 appears an article entitled, "The First Atomic Power Station of the U. S. S. R. and the Prospects of Atomic Power Development." This report contains high quality, detailed technical analysis of the power reactor which has been operating since June 27, 1954. On page 49 of volume 3 is a detailed discussion entitled, "The Comparison of an Atomic and a Coal Electric Power Station," and I call the attention of the committee to the conclusions of this analysis which proves the value of actually building prototype reactors in order to increase the practical know-how and gain experience for producing even more efficient models. One conclusion says, and I quote.

An increase in reactor size will permit a decrease in the enrichment of the uranium loaded into the reactor.

The report continues:

Reduction of enrichment lowers considerably the fuel component of the cost of 1 kilowatt of energy produced by the first atomic power station.

As I understand it, the basic purpose of the Gore bill is to achieve this same result, to build a few commercial sized reactors so that we can learn how to cut the cost of future reactors. AEC opposes this bill and any other effort to proceed more urgently than the current program because their philosophy requires primary emphasis on private enterprise. I believe they confuse private enterprise with the utility industry. I know that private enterprise is interested in the hopes this Congress will enact the Gore bill. By private enterprise I mean the manufacturers and the contractors who have worked in the atomic-energy field. I am not talking about the utility industry. But the engineering and manufacturing firms who know this industry know that you cannot hope to make it profitable until the research and development have been more thoroughly explored. Every phase of this industry is having the same problem, not only those interested in applying atomic energy to power production. But recently the AEC appealed to the firms we know best, the chemical companies. It sought to induce the chemical companies to enter the field of processing the contaminated fuel elements. Earlier this month, on May 10, 1956, the Wall Street Journal reported on this attempt as follows:

AEC seeks companies to process atomic ashes from powerplants but concerns hesitate to enter new field, see no profit in it for some time.

Mr. Chairman, I would like to insert in the record this item from the Journal in toto.

Chairman ANDERSON. Without objection, that will be done.

(The item referred to follows:)

[From the Wall Street Journal, May 10, 1956]

AEC SEEKS COMPANIES TO PROCESS ATOMIC "ASHES" FROM POWERPLANTS—BUT CONCERNS HESITATE TO ENTER NEW FIELD, SEE NO PROFIT IN IT FOR SOME TIME

By Clare M. Cotton, staff reporter of the Wall Street Journal

OAK RIDGE, TENN.—Chemical companies, under Government prodding, are pondering a new business: Removing radioactive ashes from "burned" atomic fuel from nuclear powerplants.

Most of them aren't particularly happy at the prospect because there's little hope it can be done profitably for perhaps the next 10 years. Private chemical companies aren't eager to hop into such a money-losing proposition. But the Atomic Energy Commission is urging them on. It wants "fuel de-ashers" ready to serve privately owned atomic powerplants as they start generating electricity.

Here's the reason chemistry is such an important part of atomic-power economics. Fragments from splitting uranium atoms pile up in the fuel until they quench the nuclear fire by absorbing neutrons necessary to carry on a chain reaction. Since this happens before more than a tiny amount of uranium has fissioned, complicated chemical processing of the highly radioactive fuel is needed to recover valuable "unburned" uranium.

The AEC will ask proposals from private companies to build fuel-processing plants in about 18 months. It has held 2 meetings for interested concerns, and about 100 private and industrial organizations have heard details and economics still under secret wraps.

A $2 BILLION BUSINESS

"This could be a $2 billion business by 1980," says Floyd L. Culler, chief of the Oak Ridge National Laboratory group working on fuel processing. "It will mean risking big money and a wager on growth, but the chemical business looks good from the economic aspect."

What bothers the chemical industry is the period between now and 1967. After 1962, six privately owned atomic reactors should be producing steam for turbine

generators. Officials estimate one chemical processing unit will be able to take care of all "hot" fuel from private reactors through 1967.

The Commission says it will make available "limited amounts" of fuel from its own reactors for processing by industry to help start the business. That amount is secret, but it is not secret that industry people wonder if it will support even one chemical processing unit.

Sylvania Electric Products, Inc., which has been making fuel elements, will submit a proposal to the Commission, a company spokesman says. Vitro Corp. of America is understood to be organizing a group of companies to submit a proposal. Goodrich Chemical Co. is reported to be interested.

Many companies would prefer a little longer period of research and experience before putting $30 million and upward into a processing plant before 1960, when the big volume won't start until 1970 or later. One engineer notes it will probably take a company 5 years to set up a group to operate such a plant.

"We're studying fuel processing intensively," says a top official of Union Carbide & Carbon Corp. Union Carbide's division, Union Carbide Nuclear Co., operates Oak Ridge under contract to the AEC. Atomic experts consider Carbide one of the logical companies to enter this field. Company officials, however, remain silent when asked if they will answer the Commission's request for proposals.

SUMMING UP THE OUTLOOK

A top engineer for one of the atomic powerplant builders sums up the whole situation this way: "The Commission is asking the chemical industry to take 10 years of loss operation. This is not the way the chemical industry normally operates."

Another industry man notes, though, that chemical people may have to overcome their aversion to losses to protect their own interests. "If the companies don't go in, the Commission may set up its own plants and make it pretty tough to compete later on," he says. It's no secret, for example, that many private utilities are investing in atomic powerplants to forestall development of "atomic TVA's" across the Nation.

Costs of fuel processing will be a noticeable part of the bill for atomic-generated electricity, now estimated at about 8 mills per kilowatt-hour for some recently designed plants. AEC's target figure for processing is one-half mill to 1 mill of the total cost of producing every kilowatt-hour of electric current from the atom. The Government's processing costs are secret, but no one pretends they're close to the target.

Unfortunately, the costs of fuel processing are tied closely to how much fuel is run through a chemical plant. Mr. Culler notes that such a chemical plant will have "high fixed costs and will need a high load factor, close to 100 percent." Below a certain load, costs in a chemical processing plant will skyrocket, he adds.

An additional complicating factor is that different fuel element types may require different chemical processes. Mr. Culler notes that three or more different processes would be needed to take care of fuel from the various reactors now on planning boards. Reactor fuel may be "canned" in aluminum, stainless steel, or zirconium; it may be natural uranium or various degrees of enriched uranium; it may be metallic, ceramic, or dissolved in liquids or molten metals.

A chemical process for one fuel form may not be the best for another type. Most observers expect industrial companies contemplating the Commission's program to start out with a single process. Sylvania indicates it has not yet finished the studies necessary to select its type of process.

Even with a single process, some scientists believe the Government's program is off-base. "They're pushing big plants, based on military experience," comments an engineer. "Until industry gets more experience and many more atomic powerplants are built, the program ought to concentrate on finding small, inexpensive processes," he continues.

When atomic fuel comes out of a reactor, it is highly radioactive. All chemical operations have to be done in plants requiring a minimum of maintenance with remote controls. Thick shielding to protect workers must surround many of the parts. All these things boost capital costs.

Mr. Culler, for example, estimates that one-sixth of the total capital cost of a fuel-processing plant will go to cover mechanical handling equipment. He notes little research work has been done on such mechanical problems as cutting, sawing, and disassembling metal fuel elements while still "hot."

Mr. SWISHER. This article discloses the heart of the problem. The chemical processing of the contaminated fuel cannot become profitable

until 1967, but the atomic power industry cannot operate over the long run unless chemical processing of the burned atomic fuel is available to them. So once again they will be forced to fall back on asking for Government assistance. This week we have heard the needs for Government assistance—on insurance, on tax allowances, on exemption from the Utility Holding Company Act, on long-term plutonium contracts, and in all probability next on chemical processing.

Each of these demands results in further delay. I strongly urge the committee instead to enact the Gore bill and make provision for immediate construction of the six reactors whose existence and experience will help the private utility industry and the public power segments of our economy to use this new source of energy as the economic developments ahead make it possible.

Chairman ANDERSON. Thank you.

Senator GORE. You envision the enactment of this bill, I take it from your last remark, as an aid to the private utility industry rather than an injury?

Mr. SWISHER. I do, Senator. Some of us had a brief discussion this morning, and a remark was made that all this bill is asking or calling upon the Government for is to produce what we can call a second generation of reactors, and when the bugs are out of them private utilities will then get the third generation of reactors.

Senator GORE. The private utility industry, and, in fact, all industry, and all society now benefiting from the research and development work of the Government since the initiation of the atomic-energy program.

Mr. SWISHER. You are right.

Senator GORE. Do you see any reason why we should suddenly, in 1954, after operation of the program under civilian control since 1946, suddenly repeal the 1946 act and take the Government out of the field of construction of reactors?

Mr. SWISHER. No; I do not think so. I think if you do it will fall flat on its face. That is my considered opinion.

Senator GORE. As a matter of fact, that is exactly what we did do, and it has fallen almost flat on its face, but not quite.

Mr. SWISHER. Yes, in your enactment in 1954, the amendments, except for the military phase, I do feel that the nonmilitary phases or the peaceful uses of it has fallen on its face in the last couple of years.

Senator GORE. Well, the fact stands that not one license has been issued under the 1954 act, and not one reactor is under construction. There is no assurance that any construction will start in the foreseeable future. We hope, or I sincerely hope that all of the proposals now made to the Commission will be fruitful, and will be consummated, but we have no assurance that either will.

Mr. SWISHER. I agree with you in your first statement, and I agree with you in the second statement. I see no proof that either will at this point.

Senator GORE. I believe that some of the projects will be developed, but there is certainly no certainty about it, either that they will or as to when they will. I hope for the best. I congratulate you on your statement, sir.

Mr. SWISHER. Thank you, sir.

I do believe that there will be reactors developed. The only point is, when; and I think urgency is the essence of our total overall prob-

lem today as far as this country or this Nation is concerned and its leadership in the world.

Chairman ANDERSON. I have just one short question. You referred to an increase in efficiency. That is to make it possible to reduce the number of man-hours of each unit of production. Are these plants all operated on a cost-plus type contract?

Mr. SWISHER. Yes; cost-plus.

Chairman ANDERSON. And you think that has resulted in some efficiencies?

Mr. SWISHER. Well, I do not know whether it is the type of operation or rather that type of financing of the operation that has caused it, but I think it is a technological change that has come about.

Chairman ANDERSON. Thank you very much.

Representative PRICE. I just wanted to clarify something in your statement. You referred to attending an international conference of the Confederation of Free Trade Unions in Geneva, and then having the opportunity to see the exhibits and talk to other labor representatives and scientists from all parts of the world. You meant the exhibits in the Conference on Peaceful Uses of Atomic Energy?

Mr. SWISHER. That is right, sir. Maybe I should have, for more clarification, said that I attended as a non-Government observer, representing our union.

Chairman ANDERSON. Thank you.

Our next witness is Mr. Jerry Voorhis, executive director of the Cooperative League of the United States of America, and a former colleague of some of us in the House of Representatives.

STATEMENT OF JERRY VOORHIS, EXECUTIVE DIRECTOR OF THE COOPERATIVE LEAGUE OF THE UNITED STATES OF AMERICA

Mr. VOORHIS. Mr. Chairman, I appreciate very much the opportunity to appear before this committee which it seems to me has probably the most difficult and exacting job that any committee of any legislature in the whole history of the world ever had before.

My name is Jerry Voorhis, and I am executive director of the Cooperative League of the United States of America, and I come before this committee to urge a favorable report by the committee on Senate bill S. 2725, introduced by Senator Gore.

I understand Congressman Holifield has introduced an identical bill.

The Cooperative League is a national federation of consumer, supply, and service cooperatives. Its affiliated member organizations include in their membership approximately 13 million different families who have invested in the shares of cooperative business of various kinds through which they obtain farm supplies, insurance, consumer good, electric power, savings and credit, health services, housing, and other needs.

These people are providing the solution to their own economic problem and supplying their own economic needs without relying upon the Government or any other outside agencies, and incidentally, building the economy on the basis of local ownership, in local communities.

They are giving real meaning to the term "People's capitalism" for the rank and file of the American people.

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At the outset, I shall summarize the main reasons why we urge favorable action on S. 2725. Before I do that, I would just like to say that the point of view and philosophy from which my testimony is given, is briefly this:

I am old-fashioned enough to believe that competition is still the life of trade. I am not arguing how big an enterprise needs to be to run at a maximum peak of efficiency, but I am saying that competition is the thing that spurs development. And, I carry this one step further, and I would say that it is my belief that this competition is most effective when different phases of that competition are motivated by somewhat differing purposes and points of view and objectives.

In other words, I think that it is a very healthy competitive situation when you have industries which are basically in business for the purpose of earning a profit competing with other types of enterprises whose general purpose may be the development of an industry for the sake of the whole Nation or services to people.

The Gore bill should be passed for the following reasons:

1. Because it is the most direct and certain way of speeding up the development of atomic energy for civilian, peaceful uses. At the present stage such development involves very large expenditure and a high degree of risk. In fact, substantial subsidy from the Government is, I believe, a condition of every proposal so far advanced by private corporations.

Furthermore, the even higher and more dangerous price of legalizing monopolistic controls through exclusive patents or severe modification of the Utilities Holding Company Act have been suggested.

These prices are too big. And even if paid, there would be no assurance that the more rapid development which we seek would be forthcoming. Only an agency of the whole American people, concerned solely with the general national welfare and possessed of great resources, can carry this development forward in its early stages in the manner most likely to benefit the whole Nation, including of course, private industry, in all its forms.

The example of Great Britain, which country is probably ahead of us in this field at present, is a case in point.

2. The Gore bill should be passed because one of the greatest potential benefits from atomic power development could be the equalizing of access to power for all sections of the country. This benefit, however, is not likely to be realized, unless the public itself, represented by the Government, sees that it is realized. Power shortage areas are, other things being equal, the very areas where the power industry is least interested in seeing the present rate structure modified.

But it would be very greatly in the public interest if these areas could develop their resources and industries with less expensive power than they now have. The public interest can see this and act upon it. Projects under the Gore bill can be located in areas of power shortage. The bill in fact contemplates this.

Whether or not private interests could or would do that is, to say the least, doubtful. Furthermore, it is in many of the areas of power shortage that rural electric cooperatives are having the greatest difficulty at present—and will have multiplied difficulty in future as rural power requirements continue to mount—in securing adequate sources of power.

Senator GORE. May I ask a question there? Is it a correct conclusion or deduction from the statement you have just made that you think that there are definite advantages to the geographical spread or the geographical requirements as to locations in the bill?

Mr. VOORHIS. Yes; indeed I do, Senator. In fact, it seems to me that the development of atomic energy for the first time gives promise that there might be in a nation like ours a development of basic power from whatever source derived which would be spread reasonably evenly over the country, so that you would not have areas of high cost and areas of low cost power, but where you would get a reasonable equalization of basic power for all types of industry and commerce in all parts of the country.

It seems to me that this would be a great advantage, because then the natural resources of each area, and the natural plus factors in each area could assert themselves as heretofore they have never been able to do. Consequently, I think that the language of your bill which would in effect require that the geographical location take account of this is one of the strongest points in its favor.

Senator GORE. Thank you.

Mr. VOORHIS. And, I would add that it is much more likely that this will take place if the development takes place under the influence of a broad far-sighted long-range public policy than would be the case if the entire atomic energy program is left to chance as now seems to me to be the case.

3. The Gore bill should be passed because it will help to assure the continuance of competition in the power industry. If some such measure as the Gore bill is not passed, then the field will inevitably be taken over by those few giant concerns in the country which have the resources to preempt it. There can be no doubt at all that once the period of experimentation and practical demonstration of feasibility has been passed, private industry will enter the field with vigor. This is as it should be, and as we would desire it to be. We would be very concerned about having public power or cooperative supplying of power either, enjoy anything resembling a dominance in this field.

We think that profit-making industry has basic contributions that are absolutely necessary for our economy.

We believe, however, that this has to be balanced with a concern for general public policy and for broad public development. We think this is a time when that balance is quite necessary.

But private power companies, by their very nature, have always sought and will quite certainly continue to seek a monopoly position for themselves in each area. This may be good for the power companies. But, it is bad for the consumers of electricity and it is bad for the general national welfare.

Competition in the power business has not come about through any other agencies except public agencies or cooperative ones. And the electric cooperatives are in a very vulnerable position indeed unless they have some source from which they can obtain their power beside that of their hostile competitors.

This does not mean that every utility company has been hostile to rural electric cooperatives. Many of them have been quite the opposite, but there have been cases where they have been very hostile indeed.

The Gore bill would assure that, in the early stages at least of atomic power development, there would be not monopoly, but healthy competition—the very condition most likely to promote rapid growth and worthwhile development. We would be assured that small business as well as large would get its share of the beneficial uses of power and other atomic energy products.

In considering this third reason for passage of the bill, it is well to recall that at present more than 85 percent of the power business of the country is in the hands of the private power companies. All publicly owned enterprises and all the electric cooperatives put together account for only about 15 percent.

I would like to add at this point that I do not believe that if we were to permit this new development to fall into a very few hands that regulation would be a practical answer. Indeed, I doubt that regulation has been very practical any time any place as a means of determining real costs.

I think that in this new industry, Mr. Chairman, it is only by a public or cooperative yardstick that you are going to get any accurate gage for example of what is a fair price for the Atomic Energy Commission to charge for some of the materials that it supplies, or for it to pay for byproduct ash, or what is a fair charge for a company to make for electricity developed at atomic energy installations.

4. The Gore bill should be passed because it is logical and because it is morally right. Atomic energy has been developed thus far almost entirely at the expense of the American people as taxpayers. The American people have paid for, and there is no question that they own, all right and title to basic atomic energy.

The Gore bill would assure the people of deriving from these demonstration projects a degree of direct certain benefit from their $14 billion investment. If we are eager to push forward the development of a reactor program for atomic power and for other benefits, the logical and the right thing to do is to employ the agency that can go directly at the job and go at it with nothing but the general welfare of the United States in mind. That agency is the Federal Government.

Now, may I deal somewhat more at length with the background for our reasons for supporting this legislation.

All of us are concerned that our country should not lag behind any other nations in the development of atomic energy for civilian, peaceful purposes. Especially in the present stage of the struggle between institutions of freedom and those of dictatorship, the advantage will lie more and more with those nations which make the greatest progress in improving the real welfare of their own people and thus putting themselves in better position to aid the less fortunate peoples of the world.

Consequently, it is of great importance that policies be pursued which will assure a healthy, balanced, and not too slow growth in the application of this marvelous new energy to the needs of our industry and agriculture, our homes and communities. The committee itself knows far better than I how seriously we are lagging and how urgent is the need for new means of speeding our development. From all I can learn, that urgency is great indeed.

The Cooperative League has stood stanchly through the years against monopoly in any form or in any phase of our economy. We believe

today that, next to the threat of war and the danger from totalitarian philosophies, the gravest threat to institutions of true freedom in this country is the threat of the onward march of monopolistic controls. We believe such controls are stifling in their long-run economic effect, however attractive or gaudy the promises of gigantic enterprises at any moment may be.

With respect to atomic energy, this danger appears unusually great. For sheer cost of development of economically feasible atomic reactors and powerplants gives to those agencies which possess large pools of capital a tremendous, if not a determining advantage over all small-scale business. Moreover, here is a great new resource developed at public, not private, expense, which is probably capable of changing the whole pattern of our economy in the course of time.

I heard a radio announcement a few days ago to the effect that the Russians are building six, I think, new reactors to generate 400,000 kilowatts. As I have explained, we are opposed——

Representative PRICE. That is 400,000 kilowatts a piece.

Chairman ANDERSON. There were 6 that ran around 400,000 to 600,000, and the total capacity installed at the end of 1960 is estimated at somewhere over 2,300,000 kilowatts to 2,500,000 kilowatts. It is a pretty large program.

Mr. VOORHIS. It is indeed.

I have already explained that the organization which I represent, and I, myself, personally, are deeply concerned about what we think is a serious trend toward monopoly in our country.

We also feel that this development could determine the pattern of our whole economy for a long time.

It is estimated, I believe, that $50 or $60 million at least is required to build an efficient atomic power plant.

It is our conviction that certain provisions of the Atomic Energy Act of 1954, or perhaps I should say the lack of needed safeguards in that act opened wide the door to monopoly in the atomic energy field. We believed in 1954, and I so testified before this committee, that the licensing provisions of that act were so poorly drawn as to remove responsibility from the Atomic Energy Commission for guarding against monopoly, to give overwhelming advantage to a handful of giant companies which have gained tremendous know-how at public expense through contract participation in nuclear developments, and to open the way to sealing the incipent monopoly with substantial, continuing, and thinly veiled subsidies.

The act of 1954 gave private concerns opportunity to build and own reactors. The law requires the Atomic Energy Commission to purchase all fissionable material at what is called a fair price. Plutonium ash is, as I understand it, a byproduct of the production of electricity from atomic power.

Therefore the Government is required to buy this plutonium ash from any company licensed to operate a reactor at a price whose fairness will be impossible to determine, unless the Government itself is operating yardstick plants to determine real costs, real revenues compared to those costs, and the actual fair price that should be paid.

In like manner there is no way on earth for regulatory agencies to find out what charges private companies should make for electricity produced from atomic energy unless again public agencies are operating yardstick plants to find out. Consequently, the Gore bill be-

comes more than ever necessary as a means of providing some of the safeguards against monopoly which the Atomic Energy Act of 1954 did not provide.

So we think that simple justice would seem to dictate that benefits of atomic energy be spread broadly across the Nation, more especially in areas of special need, and that all groups among the people and all elements, big and small, in the economy should share equitably in those benefits.

The Cooperative League has consistently pointed out that it is opposed to monopoly of any kind. There are those who would try to make you believe that there is a threat of Federal monopoly in the field of power production. We do not believe that there is any threat of Federal monopoly in the field of power production. Actually the generation of power by the Government meets only a small part of the national need and represents less than one-fifth of national power production.

As the previous witness has pointed out, the Gore bill may not generate more electricity than what the Atomic Energy Commission itself consumes.

For the last 50 years it has been Federal policy that the Government, in cases where it owns and operates hydroelectric or other facilities, generates the power but does not undertake its distribution. Distribution to consumers—industrial, farm, and residential—has been through existing channels. These include the profitmaking utilities, municipal and other Government systems, or the rural electric cooperatives.

Under this policy all of the utility industry—Government, cooperative, and profitmaking—would share in the distribution of power, in the expansion of power consumption, and in the experience to be gained by the construction and operation of the six reactors provided for under the Gore bill.

If, then, we are to assure rapid and sound development of atomic energy under conditions of really free economic enterprise, all these factors must be taken into account. We must look at the history of the power industry in this country and see what factors have maintained competition in that business. We must look at the history of that business and see what factors have brought about better, broader, and less costly service in the areas of greatest need.

If we do, we will find that competition has been maintained in the power business only where either public agencies or cooperatives have entered it. This is true because the power business, more than almost any other one, tends toward what the economists call "natural monopoly." We also find that better, broader, and less costly service has come to those areas where there has been healthy competition between private power companies and either public or cooperative enterprises.

The whole rate structure of the Nation is proof of this, and the very existence of electricity on our farms where there was none only a couple of decades ago is further proof of the effectiveness of the competition of cooperatives formed by the electricity-hungry farmers and of a constructive partnership between the people and their Government.

In keeping with the continuing policy of the cooperatives, plans are now underway for the cooperatives to play a role as a yardstick in the atomic power industry as well.

It is tremendously encouraging to know that farmers in Minnesota, Michigan, and Alaska have taken initiative which may help usher in the atomic age insofar as it is applied to electric power. Just as the electric coops had to demonstrate to the industry that it was practical to provide low-cost power for millions of American farm homes, so the co-ops are determined to try to prove to industry and to the Government that it is practical to use atomic energy now to serve these farm needs.

The Rural Cooperative Power Association at Elk River, Minn., has applied to the Atomic Energy Commission for permission to build a 22,000 kilowatt, boiling water reactor. In Alaska the Chugach Electric Association in the neighborhood of Anchorage, has made application for a 10,000-kilowatt, sodium-cooled, heavy water, moderated reactor. In Michigan, the Wolverine Electric Cooperative at Big Rapids has applied for a 10,000-kilowatt, aqueous, homogeneous reactor.

The Atomic Energy Commission has accepted as the basis for negotiations the proposals of the Minnesota and Michigan co-ops. The Alaska proposal was deferred. We sincerely hope the Atomic Energy Commission will move forward quickly with these negotiations so that there can actually be a signed contract and construction of the reactor very soon. Undue delay on the part of the Atomic Energy Commission could kill the effective application of atomic energy to power production in these areas.

There are several unanswered questions, but these projects, we believe are highly practical. The co-op applications are in areas where the farmers are paying high costs for power. In 1954 the wholesale delivered power cost for the Chugach co-op was 19.4 mills. The Elk River co-op was paying 8.4 mills and 18.2 mills. The Wolverine co-ops were carrying costs running from 5.6 mills to as high as 14 mills.

We have reason to believe that atomic energy produced today is economical enough to meet those higher costs and would have practical application in many rural areas. We are pleased that the Rural Electrification Administration has seen its way clear to approve loans to help facilitate these developments.

Any policy respecting basic power must have one main purpose if it is to serve the best interest of the United States of America. That purpose is to make that basic power as abundant and as cheap as it can possibly be made.

This is so far a very simple reason. We do not put air meters on everybody's lungs and give some company a license to charge the people for the air they breathe. The reason we do not do this is because we recognize that air is a universal and absolute necessity for every living being and because we know it would be bad for every family and every farm and every industry and every business and every city and every State to have the supply of air restricted or to have an economic barrier erected against the people having all the air they need to breathe.

Water is in the same classification with air. It is a basic universal absolute requirement for life. So for a long time we have done every-

thing we could to make water for domestic, industrial and agricultural purposes just as abundant and just as cheap as we could make it. We have provided water where it was scarce either through public agencies or, in the case of water for irrigation, through cooperatives and mutuals.

I believe there are moral reasons as well why we act as we do respecting air and water. I believe that we recognize that God provided air and water as His gift to all mankind and that He never intended either of them to be controlled or monopolized or sold at a profit by any special interests. No people can be free unless it has an abundance of air and water.

Now, the question arises whether there are any other elements of our life in the United States today which are so universally necessary—both to the people and to all forms of industry and business—that they should be made as abundant and as cheap as possible in the general interest of the whole Nation. And, if we are honest, we will find that there are such elements. One of them is communication by mail.

Another example is public education. We simply say that it is to the interest of our whole Nation that all the children of all the people should be educated to become good and useful and effective citizens. We say we do not want any economic barriers to stand in the way of this. So, instead of licensing somebody to make a profit out of the education of America's children, we provide it free to everyone—and even require bachelors to help pay for it.

Well, is there anything else? Yes. There is. There is basic power. Our civilization just could not possibly carry on without electric and similar types of basic power. Our industries could not run. Neither could our commercial establishments.

Our cities would be miserable, unsafe places without it. Our national defense would be impotent without it. Our homes would be dark without it. And our farms simply could not go on increasing their production as they have almost miraculously done in the past several years—without electric power brought to them by rural electric cooperatives.

Furthermore, as with air and water, we must, if we have any religious sense at all, deeply feel that God put power into the atom or into falling water not that it might become a private preserve of absentee owners, but that it might benefit all mankind and be as abundantly available to them as possible.

So we must conclude that any policy which restricts the supply of electric power or adds to its cost to municipal, governmental, commercial, domestic, industrial or agricultural users is a wrong policy and one which thoughtful and patriotic citizens will oppose with all the vigor at their command. For no people can be truly free today unless it has an abundance of electric energy.

This does not at all mean that all or even a major part of our electric power should be generated, transmitted, and distributed by public agencies or by cooperative agencies.

It does mean that the yardstick principle is as sound today as it was when it transformed the Tennessee Valley from a depressed area into one of the brightest economic spots in the Nation. It does mean that enough electricity must be not only distributed but transmitted and generated by agencies with a direct interest in making it as

abundant and cheap as possible to bring the whole industry up to this standard of operation.

If these principles are sound, and I am sure they are, with respect to a nation's basic power in general, then they are even more sound and right when it comes to the development of atomic energy. For here is a great new resource whose potential we do not yet know except that it can almost certainly transform the life of man—for better—or, wrongly used—obliterate that life forever.

This new resource has been developed almost wholly at public expense. The American people, all of them, have spent, I believe, upward of $14 billion to develop atomic energy. No sane person will question the fact that this basic energy is the property of the whole Nation and of all the people together.

It is hard to see, therefore, what sound or logical reason can be advanced against a proposal like the Gore bill, under which the American Nation would proceed to carry forward demonstration projects at public expense and for public benefit in the new and challenging and very critical field of atomic energy applications to the strength and welfare of our entire Nation.

Chairman ANDERSON. Are there any questions that you would like to ask the witness?

Senator GORE. I want to thank the former Congressman Voorhis, and my friend, for his very able testimony.

Chairman ANDERSON. Thank you very much, and thank you particularly for your cooperation.

We are always happy to have you come down.

Mr. Browne is our next witness.

STATEMENT OF HARRY L. BROWNE, MANAGER OF NUCLEAR PROJECTS OF THOMPSON PRODUCTS, INC., AND CHAIRMAN OF THE CASE INDUSTRIAL NUCLEAR CENTER, CLEVELAND, OHIO

Chairman ANDERSON. Mr. Browne, from the Industrial Nuclear Center, spent considerable time in Albuquerque, and it was a matter of deep regret to the community that he left. I am especially commissioned to tell you that we will be glad to have you back any time you can make it.

Mr. BROWNE. Mr. Chairman, I would like to preface my prepared statement by explaining it does not relate directly to the proposed Gore bill and I am not appearing to testify on that legislation or on the issue involved in it.

However, in response to the telegram sent by you, I am prepared to report briefly on the status of a new development in private industry's entry into the nuclear energy field. If the committee would be interested in hearing of this new development, I will gladly read my brief statement or alternatively I will be happey to enter it for the record.

Chairman ANDERSON. We would be very happy to have you read it.

Mr. BROWNE. Thank you, Mr. Chairman.

My name is Harry L. Browne, and I am pleased to appear before this committee in response to a telegraphic invitation addressed to Dr. Keith Glennan, president of the Case Institute of Technology by

your honorable chairman. Since Dr. Glennan is out of the country, I have been asked to report to this committee on the status of certain plans for a nuclear center to be located in northern Ohio and which we have tentatively identified as the Case Industrial Nuclear Center. My position with respect to this center is that of chairman of a Nuclear Advisory Group which Dr. Glennan established earlier this year.

Plans for this nuclear center have developed from the desires of a certain segment of northern Ohio industry to have a local facility in which to train prospective and current employees in the new field of nuclear energy and in which to undertake privately directed research development and testing in this same field. It was natural for Case Institute, long associated with industry in community endeavors for the common good, to offer itself as the nucleus and focal point around which planning for such a center could develop. It was the Geneva Conference on the Peaceful Uses of Atomic Energy of last August which dramatically opened industry's eyes to the challenge and opportunity which had been presented to it by the Atomic Energy Act of 1954.

It was shortly after that conference that Case Institute, encouraged by forward-looking businessmen of Cleveland, took steps to insure that northern Ohio would be in a position to meet that challenge and seize that opportunity.

Dr. Glennan, as president of Case, formed an investigative and advisory group from members of the Case faculty and from Industry early this year to undertake the conceptual planning of a nuclear center.

Industrial members of this group are: Dr. Richard G. Bauman, B. F. Goodrich Co.; Mr. Neil J. Carothers, assistant to the president, the Albert Higley Co.; Mr. Clarence A. Dauber, director of civil and mechanical engineering, Cleveland Electric Illuminating Co.; Dr. Clarence E. Larson, vice president, research, National Carbon Co., Division Union Carbide & Carbon Co.; Dr. Robert P. Petersen, director of nuclear research, Republic Steel Corp.; Mr. Harry L. Browne, manager of nuclear projects, Thompson Products, Inc.

These men, most of whom have had substantially responsible positions in the Government's atomic-energy program or presently occupy such positions in their respective company's nuclear programs, have given unstintingly of their time, knowledge, and experience in firming up the conceptual plans for the Case Industrial Nuclear Center.

Case also has engaged an engineering firm, the Austin Co. under contract, to make certain investigations and analyses which have helped the advisory group in its deliberations and which will provide a firm base of information on which to make definite plans for the nuclear center.

I can report with pleasure that today the preliminary study is completed, and the proposed nuclear center has been scoped as to size, cost, and general location. Case is now ready in collaboration with its industrial partners to enter into a more definite planning stage. The target date for operation of the center is July 1959.

The Case Industrial Nuclear Center will serve all commercial and noncommercial organizations who wish to join with and support the center of its program of training, research, development, and testing in the nuclear-energy field. Its principle purpose is to further the

peaceful utilization of the atom in and for the northern Ohio community.

We of the Case industry family take pride in the fact that this nuclear center was conceived by northern Ohio industry and its eleemosynary partner Case Institute as private industry's response to the challenge which was hurled as Government's domination of the atom was relaxed. It will provide one answer to the question of how private industry can exploit the atom for the common good in the face of the tremendous problems of training personnel and carrying on research, development, and testing programs in necessarily unique facilities.

I wish to thank the members of the committee for permitting me to make this report on the status of the Case Industrial Nuclear Center.

Chairman ANDERSON. I want to say, Mr. Browne, that we are happy to have you make this statement for at least two reasons, and many more, probably. In the first place, Dr. Keith Glennan has been a fine helper to this committee by his service on the panel, and we all very much appreciate his service on the Commission.

We are glad to hear of any of the things which he seeks to do. I was interested, because of the connection it has to the comments made earlier by Mr. Swisher, when he was saying that in-plant training can be useful. Here you have decided that industries can help in finding what the problems are, and in training manpower and trying to make some contribution to this problem.

We know that we have a manpower problem. We know that we have a problem on how to go about bringing these nuclear problems closer to individual businessmen within a section of the State.

That is why I think this is of interest to our committee. Mr. Price, as you know, did a good deal of work in the collection of material on the manpower situation. He is a whole fund of knowledge in himself, and I hope you will bear that in mind.

We will resume in this room at 2 o'clock this afternoon, and again, I must explain that if some witness is testifying and I do not arrive, it is because of the press of business.

(Whereupon, at 12:10 p. m., the hearing was recessed to reconvene at 2 p. m., the same day.)

AFTERNOON SESSION

(The committee reconvened at 2 p. m., pursuant to recess.)

Senator GORE (presiding). The committee will come to order.

Senator Anderson is speaking on the floor at the moment and asked me to start the meeting and he will come in later.

The first witness is Mr. Clyde Ellis, general manager of the National Rural Electric Cooperative Association. Mr. Ellis.

STATEMENT OF CLYDE T. ELLIS, GENERAL MANAGER, NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION

Mr. ELLIS. Mr. Chairman, my name is Clyde T. Ellis. I am general manager of the National Rural Electric Cooperative Association, which is the national service organization of the rural electric systems representing about 91 percent of the operating rural electric systems

in the United States, including Alaska. These systems serve about 3,736,470 farm families and rural establishments.

Sitting at my left is Dr. Clay Cochran, who is director of our legislative research and management department, and Bob Kabot, who is secretary of our atomic energy study group. If it is agreeable to you, I may have to call on them for help.

I appreciate the opportunity of appearing before your committee to again testify on methods to accelerate the civilian power reactor program. Something must be done to accelerate this program and we believe that one of the ways this can be done is through the Gore bill, S. 2725, which authorizes and directs the Atomic Energy Commission to construct six nuclear power facilities, each of a different design and located in different geographical areas of the United States so as to demonstrate the practical value of these reactors for industrial or commercial purposes. Such legislation is absolutely essential if the present civilian power reactor program is to get off dead center.

We have appeared several times before this committee in support of legislation for the construction of reactors by the Federal Government. When I appeared before the committee on July 15, 1953, I made the following statement:

> In connection with research, we feel some thought should be given to the Atomic Energy Commission's developing the pilot atomic powerplant in conjunction with one of its present atomic weapons plants. If successful, the Atomic Energy Commission could economically utilize the electric energy for its own requirements and also the plutonium for its weapons needs. At the same time this would release vast quantities of public, and in some cases private, power for civilian needs where it can be readily utilized. If this were successful for instances at Oak Ridge, Tenn., the whole TVA area would be assured of needed power not now in sight.

When I made this statement in 1953 it was long before any one introduced legislation similar to the Gore bill, and it was long before we had much knowledge of the different types of reactors.

Also our association fought long and hard for the Johnson amendment to the Atomic Energy Act of 1954 which passed the Senate and which would have permitted the Federal Government to construct commercial atomic powerplants. If this amendment had been approved also by the House, our civilian atomic power program would not be in the stalemate it is in today, assuming sympathetic administration. The Government could have moved ahead, instead of waiting and beggingand encouraging, with all sorts of financial incentives to private industry which almost 2 years after the passage of the 1954 act still hasn't turned any dirt for the construction of a private reactor. Instead private industries are now demanding even higher prices for participation in this program, including an amendment that would exempt them from provisions of the Holding act which has protected us from the outrages of the Insulls and the Hopsons. How high a price must we pay for their participation and how long must we continue to wait?

Also, when I testified before this committee on February 28, 1955, I stated, and I now repeat:

> We would like to see the Congress authorize the appropriation of funds for the construction of large demonstration nuclear powerplants in areas where the AEC is consuming a large part of the available power supply.

That is happening in our own TVA country, Mr. Chairman, and in the Pacific Northwest.

To us it seems very logical that the AEC should construct these demonstration plants itself, and also sell the power itself. The construction of such yardstick plants should give the American people a pretty good idea of what the cost of atomic power will really be. Also, it would relieve the tight power situation which exist in some of these areas where the AEC is consuming a major portion of the available power supply. Such an arrangement certainly is preferable to the Dixon-Yates type of deal, which would tend to destroy the TVA yardstick and increase the cost of power in many areas of the country, not just in the Tennessee Valley.

I wish to call your attention to section 7 of the first part of our statement of atomic power policy. * * * This section reads as follows: "Direct the AEC to construct and operate several small to large scale experimental reactors immediately to supply power to AEC's own operations." This statement, which was adopted unanimously by our membership at our recent annual meeting, would, for instance, place us strongly behind such measures as the bill introduced by Senator Gore on February 11, 1955, to authorize the appropriation of funds for the construction by the AEC of an experimental facility for production of nuclear power from nuclear fission. We believe the AEC should be given such authorization and also that funds should be appropriated for this purpose. We believe that limited construction by the AEC itself is more desirable than the subsidy which will be given private industry through the demonstration power reactor program. We believe it would not only be more economical, but would give us a better indication of the actual costs of the generation and production of atomic power. From such construction, the AEC should be able to derive a real atomic power yardstick which could be used to measure the cost of commercial atomic power. We feel the joint committee and the Congress would be performing a real public service by approving S. 1049. We hope your committee will hold hearings on this bill in the near future, and at that time we would like to have the privilege of testifying.

Our support of this type of legislation is not something new, but we have consistently supported this approach even before the actual legislation was introduced. Also, our members assembled at annual meetings consistently considered and adopted resolutions supporting such legislation. It is, of course, through such resolutions and action of our board of directors that the policy of this association is developed. This policy guides us in presenting testimony before committees of the Congress.

PRESSURE AGAINST FEDERAL PARTICIPATION

Apparently, there is a lot of pressure against Federal participation in the civilian power reactor program. I noted in a recent article which appeared in the Washington Post and Times Herald, dated Saturday, May 19, 1956, that even the Department of Commerce has gotten into the act. The Business Advisory Council of the Commerce Department, in a meeting at Hot Springs, Va., on May 18, which was attended by Secretary of Commerce Weeks and also AEC Chairman Admiral Strauss issued a well timed blast against increased Federal participation in the civilian atomic power program. The AEC officials must be really scared when they have to call on this lobbying organization of the Department of Commerce for help. This meeting was held with the express purpose of developing opposition by giant private business to legislation like the Gore bill. I would like to quote a few paragraphs from this article which appeared in the Washington Post and Times Herald on May 19, 1956:

A Government-subsidized "crash program" of atomic power development is needless, business leaders said today, if Congress will write new rules for atomic patents and insurance.

Members of the Business Advisory Council of the Commerce Department, meeting here with Secretary of Commerce Weeks and Chairman Lewis L. Strauss

of the Atomic Energy Commission, said private utilities are moving rapidly toward commercial nuclear power and could go faster if "obstacles" were removed. * * *

The sessions demonstrated, according to some of those present, that a major segment of industry opposes the proposal of AEC Commissioner Thomas E. Murray for heavy Federal outlays to promote atom-generated electric power. Public power advocates support his views.

I believe it is disgraceful that the propaganda machine of another Government agency should be brought in to level in its big guns against a sincere attempt to get the civilian power reactor program off dead center.

We did a little research on who comprises this Business Advisory Council of the Commerce Department and we note that the following officials of power companies are members:

John D. Biggers, director, Toledo Edison Co., a power company; Paul C. Cabot, director, Tampa Electric Co.; Walter L. Gisler, director Edison Electric Institute, and president, Detroit Edison Co., a power company; Robert March Hanes, director, Carolina Power & Light Co.; Devereux C. Josephs, chairman, Consolidated Edison Company of New York, Inc., a power company; J. W. McAfee, president and director, Union Electric Company of Missouri, president and director, Union Electric Power Co., Monsanto, Ill., and president and director, Electric Energy, Inc.; Earl M. McGowan, director, Alabama Power Co.; Paul B. McKee, president and director, Pacific Power & Light Co.; Alden G. Roach, director, Southern California Edison Co., a power company; Kenneth A. Spencer, director, Kansas City Power & Light Co.; John C. Virden, director, Cleveland Electric Illuminating Co.

It goes without saying that no representatives of the competitive elements in the electric industry, the rural electric co-ops and the public systems, are on this Big Industry Advisory Committee of the Department of Commerce. It is really a stacked committee composed of some gentlemen who for years have been in the forefront in the fight to delay this civilian atomic power program until it looks like a sure thing and then step in and reap all the benefits from it. We believe that their actions in this regard are a disservice to their country. Some of them have fought the rural electrification program at every opportunity. We are disappointed that they cannot take a more constructive view of this program and work for an abundant atomic power economy at home and meet the serious international competive threat we face abroad.

GORE BILL ESSENTIAL

We believe the Gore bill is essential, if our country is to bring some life into the civilian atomic power program. We believe its passage by the Congress is absolutely necessary for the following reasons:

1. We face a serious international competitive threat in the development of civilian atomic power. We do not believe at this time that we are adequately meeting this threat.

2. The demonstration power reactor program is not working. It is bogged down in a lot of delays associated with, or caused by, detailed negotiations which extend over periods of years.

3. There is no private atomic power program worthy of the name. There are a lot of plans and proposals but no actual private construc-

tion (the Duquesne Light Co.'s Shippingport plant is being financed by the AEC and through tax writeoffs obtained by Duquesne).

Senator GORE. Of course, this was initiated and is progressing under the 1946 act instead of the 1954 act.

Mr. ELLIS. That is right. We think we will never know what the real costs involved in that plant are.

4. Most private reactors require large hidden Government subsidies, tax writeoffs, tax deductions, research and development help, and so forth. Subsidies in themselves are not bad and are probably necessary if we are to participate in this program, but, perhaps, it might be more economical to have these reactors constructed directly by the Federal Government. At least it will make it easier to measure the actual cost of such construction and the rural electric systems will benefit more from it.

5. Yardstick atomic powerplants are needed to determine and measure the actual cost of constructing and operating such plants and to bring a little healthy competition into this program.

6. We believe the Gore bill will broaden the participation in the civilian power reactor program. Such little participation as now exists is limited mainly to the large manufacturing companies. This threatens to impose effective monopoly or near-monopoly on a new and vital industry and this condition will only result in high cost atomic power.

7. The budget proposed by the administration does not give sufficient emphasis to the development of civilian atomic power. Compared with the total AEC budget only a pittance is included for civilian atomic power development. The Gore bill with its primary emphasis on a dynamic program financed by the Federal Government should result in larger appropriations to carry on this vital program. Since this program will be primarily civilian in character, it will be much easier to keep track of the funds that are appropriated for it and the progress which is being made. It will not be the intermingling of military and civilian reactors which is now taking place in most of the research and development work being carried on by the AEC.

We would like to elaborate on each of the points I have made as to why the Gore bill should be favorably reported out of the joint committee and receive favorable action by the Congress.

FOREIGN COMPETITION

The first point I made was that we must get the civilian atomic power program going in order to meet the strong threat of foreign competition. We do not feel that we are competent to assess the progress which is being made by some of the foreign countries, especially the Russians. Apparently, even the AEC disagrees with our country's top intelligence agency on the progress being made by the Russians. But they are making progress and they are now generating electricity commercially from an atomic reactor. This is more than our country is doing and I'm sure this achievement is being used by the Russians as appealing propaganda throughout the world, particularly in the underdeveloped countries.

Also, England is going ahead with a comprehensive civilian atomic-power program. In fact, Sir Edwin Plowden, head of Britain's

Atomic Energy Authority, in an article appearing in the Washington Post and Times Herald on May 15, stated that England may go ahead of the United States in developing commercial atomic power because its needs are "very urgent." We can well understand why the English needs are quite urgent, but at the same time we have many areas in this country and Alaska where the rural electric cooperatives are paying very high wholesale power costs. For instance, the year ending June 30, 1954, the average wholesale power cost for the rural electric systems in Alaska was 2.3 cents per kilowatt-hour; Maine, 1.51 cents per kilowatt-hour; Vermont, 1.35 cents per kilowatt-hour; New Hampshire, 1.28 cents per kilowatt-hour; New York, 1.12 cents per kilowatt-hour; Minnesota, 1.35 cents per kilowatt-hour; Wisconsin, 1.33 cents per kilowatt-hour; Michigan, 1.28 cents per kilowatt-hour; and Iowa, 1.28 cents per kilowatt-hour. Also, in most areas our loads are continuing to double every 4 to 5 years. We feel strongly that our needs, because of our present high wholesale power costs and our constantly increasing loads, are also urgent. We will only receive some assistance in meeting these difficult power problems if legislation like the Gore bill is enacted.

Our country has always been the leader among the countries of the world in making technological progress. Are we to fall behind in the development of what might be the major source of electric generation in the world, because private industry is not yet able or willing to invest the considerable sums of money required to advance atomic power technology as rapidly as possible?

Senator GORE. May I ask a question there, Mr. Chairman.

Chairman ANDERSON. Senator Gore.

Senator GORE. Mr. Ellis, you are acquainted with the requirement of geographical distribution under the terms of the bill I introduced?

Mr. ELLIS. Yes, I have an idea of what it is.

Senator GORE. Do you think that the location of an atomic reactor in high cost power areas would contribute toward the economic feasibility of the plant?

Mr. ELLIS. Yes. I would think that if the apparent principal barrier under known methods is the expected high cost of the wholesale power to be produced, then the plant would be feasible first in the areas that now have the highest wholesale power costs. But I don't think that is the only consideration. I think there would be much merit in placing a plant in the Pacific Northwest where there is now and there will be a greater power shortage, where AEC is using tremendous blocks of the power being developed, and likewise in the TVA country, where an AEC atomic power plant located alongside the other giant AEC installations that are eating up a large part of the available power, could be operated perhaps more efficiently than in some of the high-cost power areas.

Senator GORE. Do you view the geographic dispersion of 6 plants or 12 plants or whatever the bill might provide as desirable?

Mr. ELLIS. We do. We think there are different situations existing in different parts of the country that might give us different answers, and therefore, the testing program ought to be universal, subject to whatever limit of number of plants the Congress would deem advisable.

Senator GORE. One witness before the committee yesterday called the committee's attention to one phase of this matter which I do not

believe had been suggested to the committee before, to wit, that in the event of war our present lines of transportation of both coal and oil and gas might be severed by a catastrophe, by an explosion, by bombing, and therefore he pointed out as one advantage of a nuclear powerplant the lack of the necessity of transportation to bring fuel. Applying that to an area far removed from conventional fuel, there you would certainly have an advantage in the location of an atomic powerplant.

Mr. ELLIS. Yes, sir, we think that is very important. If the Congress of the United States is going to spend billions and billions and multiple billions year after year and the major part of our whole spending is on war and matters related to war and preparation for postwar, and if we are going to spend billions of dollars on this SAGE project which is just getting under way for these radar installations all over the country, then some attention ought to be given, it would seem to us, to keeping the most vital source of energy available in case of war. Certainly, what you mentioned, I think, is important.

DEMONSTRATION PROGRAMS NOT WORKING

The second reason why we believe it is absolutely essential that the Federal Government undertake an aggressive power-reactor program, as envisioned by the Gore bill, is that the present demonstration power-reactor programs are not working. The objective of the demonstration programs seems to be to get as much private participation as possible in the construction of experimental civilian power reactors. This may be a worthy objective, but if it is resulting in long unnecessary delays in the development of this new technology, it is probably doing more harm than good. It is now 14 months since the deadline for submitting proposals under the first round of the demonstration power-reactor program and still not one contract has been signed for the construction of these demonstration reactors. Only recently on February 9, 1956, the fourth of the first round demonstration proposals, that of Yankee Atomic Electric Co., was determined by the AEC to be an acceptable basis for negotiations of a contract. This was 9 months after the deadline for the submission of proposals. This is progress at a snail's pace, if it is progress at all.

We were told by one of the groups whose first round proposal was determined by the AEC to be an acceptable basis for negotiation of a contract, that this was only the beginning and that it was a lot more tedious and time consuming to negotiate the actual contract than it was to prepare a detailed proposal for submission to the AEC. How much longer will it take before contracts will be signed for the construction of some of these reactors and dirt actually turned? If it takes almost a year to determine whether a proposal is an acceptable basis for negotiation, how long is it going to take to actually negotiate the contract? It would not be necessary to encounter such long delays, if this was a completely federally financed program, or some part were. Is our objective to undertake a vigorous atomic-power program and develop this new technology as rapidly as possible or is it to develop this technology always keeping uppermost in our minds that it must be done at the smallest possible cost to the Federal Government even if this involves 2 or 3 years of negotiations and delay before a reactor

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can actually be constructed? We realize there are very tough technical and financial problems to be solved in connection with these proposals but at the same time we wonder whether this is really the approach to get reactors constructed. These great time lags certainly do not indicate that this is the way to get the job done. We believe in economy but we also believe in progress. The way to get the job done is for the Federal Government to undertake the construction and operation of these reactors through the authorization provided by the Gore bill.

Also, the second round in the demonstration power reactor program is lagging badly. The dealine for this second round, which was for proposals in the small-scale class or 5,000 to 40,000 kilowatts, was February 1, 1956. Seven proposals were received at that time including three from cooperatives.

On April 19, 1956, approximately 7 weeks after the deadline, the AEC announced that 2 of the proposals, the Rural Cooperative Power Association of Elk River, Minn., and the Wolverine Electric Cooperative of Big Rapids, Mich., were "approved in principle, as a basis for negotiations" of contracts.

We, of course, are pleased with the fact that 2 of the 3 electric cooperative proposals have been approved by the AEC as a basis for negotiation. But this only means that now these cooperatives must go down the long hard road of contract negotiations with the AEC and perhaps a year or two from now they may be able to enter into a contract.

Here it is almost 4 months since the AEC deadline for submission of proposals and only 2 of the 7 small-scale proposals have been approved by the AEC as an acceptable basis for negotiation of contracts. Based on experience in connection with the AEC's "first round" it will probably be a year or more before a majority of these second-round proposals will be either accepted or rejected and even longer before contracts are signed and construction begins. Is this the way to get this program under way expeditiously?

NO PRIVATE ATOMIC POWER PROGRAM

If these demonstration programs are not working, what about private development without any Federal assistance? The third reason why the Gore bill is essential is that there is no private atomic power program worthy of the name. When one talks about the private reactors being constructed, he becomes engaged in quite a numbers game. Some say there are none, some say there are 4 and some say there are 9. There are a lot of plans and proposals but there is nothing actually under construction. Not an ounce of dirt has been turned for the construction of a private reactor.

I think the status of most of the proposals made by the private power companies, either under the demonstration program or financed on a so-called private basis, was made clear in the testimony before your committee on February 29, 1956, appearing on pages 326 and 327 of the printed hearings:

> Senator GORE. I would like to address a question to whomever is the proper one to answer it. Mr. Davis, you have said that five are under way. What do you mean by the term "under way"? Is it under way in the proposal stage, or in the construction stage?

Mr. DAVIS (Director, Division of Reactor Development, AEC). Well, none of these, with the exception of the pressurized water reactor, are yet in the construction stage. The others are in varying states of study and design and negotiations with the Commission, in the case of Commission support. It is a little hard to describe except in each individual case what the stage is. But none of them have actually begun construction, this is true.

Chairman ANDERSON. Well, the bids were taken and proposals were taken April 1, 1955. This is March 1, 1956, today. Has anything been finally done under the proposal of Commonwealth Edison?

Mr. DAVIS. Well, Commonwealth Edison was a proposal made under the power demonstration reactor program, and one which did not involve any Government participation. So they have asked instead, simply for a license to construct and operate this reactor.

Chairman ANDERSON. Has it been granted?

Mr. DAVIS. The license has not, I believe, been granted.

Chairman ANDERSON. No. 2, is Consolidated Edison of New York. It is under license feature, also, is it, or not?

Mr. DAVIS. Consolidated Edison is under a straight license, too.

Chairman ANDERSON. Has it been granted?

Mr. DAVIS. I do not believe that a license has been granted.

Chairman ANDERSON. And the next is Detroit Edison. It is under what kind of a program?

Mr. DAVIS. Detroit Edison, that is the Power Reactor Development Co., that is under the power-demonstration program.

Chairman ANDERSON. Has any final decision been made on its application?

Mr. DAVIS. Well, they are applying here for assistance from the Government as well as for a license.

Chairman ANDERSON. But they applied in April of 1955, and has it been completed as yet?

Mr. DAVIS. We are still negotiating the contract with them, and we still have not granted them a license.

Chairman ANDERSON. And the consumers group in Nebraska, they filed before the April 1 deadline?

Mr. DAVIS. That is correct.

Chairman ANDERSON. And what is the status of their negotiations?

Mr. DAVIS. We are still negotiating the final details of the contract with them.

Chairman ANDERSON. So that your term, "underway" means underway still with the Commission. Is that right?

Mr. DAVIS. I think it means a great deal more than this, because in each case the manufacturers concerned are taking very positive steps to bring these reactors into being. For example, the Commonwealth Edison plant is a boiling-water reactor and the General Electric Co., who are their contractors, have established a laboratory in California and they are proceeding to carry out development work, and detailed design work on this reactor. I think this is certainly underway.

Chairman ANDERSON. Has any ground been broken?

Mr. DAVIS. No ground has been broken that I know of on the actual construction of the reactor itself.

Chairman ANDERSON. Except for Shippingport?

Mr. DAVIS. That is right.

One proposal which was not discussed in this exchange is that of the Pennsylvania Power & Light Co. and I think the status of that proposal was amply described by this same Mr. Davis, when he stated in the press seminar on civilian power reactor development held at the AEC on December 6, 1955:

* * * Pennsylvania Power & Light, who are planning to build with the assistance of Westinghouse, a homogeneous reactor, having it built in 1962. They are saying that they will only build it if by 1958 it looks as though it will be economic when it is completed.

That is a lot of if.

In other words, the private power companies want to be certain they are building what amounts to a sure thing. This certainly cannot be the basis under which we undertake the development of a new technology.

Senator GORE. I do not know that I could point an accusing finger—I do not think I would even desire to point an accusing finger—at a private company that did not want to undertake a project until they are assured "it will be economic when it is completed."

Mr. ELLIS. Neither do I.

Senator GORE. After all, private enterprise operates on the profit motive as its incentive. I am strongly for the profit motive. I would not abolish it. It is the spring behind our private enterprise system. I would not want to castigate a private concern that did not wish to engage in a project that was going to be a losing proposition. After all, the board of directors has considerable responsibility to its stockholders to safeguard their funds. This is one field in which the profit motive cannot be relied upon to bring about development because the prospect of profits are not immediate.

That is why I think it is necessary, or one reason why I think it is necessary, that the Government continue to pioneer in the development of power reactors.

Mr. ELLIS. I agree fully, Mr. Gore, and I did not mean to be condemning the companies. I do mean to be saying that the program is lagging and is not getting done and if there is any criticism of the companies it is directed toward the attitude which they take in opposing the Government moving ahead when they cannot or will not do it.

Chairman ANDERSON. May I stop you there, also, to say that on page 12, where you say, "Not an ounce of dirt has been turned for the construction of a private reactor," I do not know what is completely technically true. I suppose it is. Just bear in mind that the Pacific Gas & Electric and General Electric have turned some ground for a small plant which eventually will emerge as Commonwealth. This is a small one but they hope to test out their core design and various other designs and probably the Commonwealth reactor will pretty largely follow the pattern of what they are now constructing in California. At the same time they are doing some test drilling on the site in Illinois and I think it is prudent to take it easy as they are from that standpoint.

I would like to see some reactors built. I have expressed that frankly. The same thing is true of Consolidated.

Babcock & Wilcox are building a plant in Virginia that has a relationship to the final reactor.

I do not know whether your statement with reference to the reactor is wrong, but it is at least a partial step in the right direction. I wish we had more of them.

Mr. ELLIS. I thank you for your statement. I think it only emphasizes the point which I am trying to make and that is that not an ounce of earth has been turned on a privately owned reactor for a commercial power operation.

My point is, as you mentioned, that these two are merely pilot jobs for the purpose of testing out somewhere else—in the California case, not even in the area where they would operate—what they would hope to be measures of cost and of performance in a larger plant. That, at least, is the way I understand it.

Elmer S. Lindseth, president of the Cleveland Electric Illuminating Co. and a member of the Edison Electric Institute committee on atomic power, in his testimony before this committee on March 6,

1956, engaged rather freely in this numbers game to determine how many nuclear powerplants the private power companies and their associates are building. In the list of 9 nuclear powerplants which he had inserted on pages 539 and 541 of the printed hearings only 2 are now under construction, the Shippingport, Pa., pressurized water reactor and the sodium graphite reactor being built by the AEC in conjunction with the North American Aviation Co. Both of these reactors are being constructed for the AEC primarily with AEC funds.

It is interesting to note from this list that the Edison Electric Institute, a power company propaganda outfit, considers the Southern California Edison Co. to be a participant in the construction of the sodium graphite reactor. Actually all the Southern California Edison Co. is doing, according to the reports we have, is installing the conventional generating equipment and purchasing steam from the reactor.

The remaining seven reactors included on Mr. Lindseth's list are not even under construction and some of them are proposals for pretty far in the future. For instance, one which is included presumably will be constructed by the Florida Power Corp., Florida Power & Light Co., and Tampa Electric Co. But according to this list it is not even known what type of reactor it may be and when it may be in operation.

Also, two other reactors on this list, the Power Reactor Development Corp. fast breeder reactor and the Yankee Atomic Electric Co. pressurized water reactor, are proposals submitted under the AEC's demonstration power reactor program and would require Government financing and assistance.

So this Edison Electric Institute list contains some reactor proposals so far in the future that the private companies cannot even state the type of reactor which is being considered, others are being financed almost completely by the AEC, and still others would be partially financed by the AEC either directly or indirectly with some Government subsidy in the form of accelerated tax writeoffs, income-tax deductions, and research and development work being conducted by the Federal Government. The question is not really how many proposals or plans have been submitted by the private power companies and their associates but when would they be built? What guaranty do we have that they would ever be built? These figures and statistics look fine as power-company advertisements but what firm commitments are there that these reactors would be constructed? Let's cut out this numbers game and get this program going.

The AEC announced on May 4 that it was granting construction permits to the Consolidated Edison Co., of New York, and the Commonwealth Edison Co., of Chicago, for the construction of reactors. It is interesting to note that both of these construction permits were issued a year after these companies first applied for licenses. Consolidated Edison first applied for a license on March 22, 1955, and the Commonwealth Edison Co. on March 31, 1955. Construction permits are not actual licenses, but still it took over a year to grant them. In both of these cases, before a license can be granted the companies must submit "hazards summary reports," which must be found by the AEC to give reasonable assurance that the final design provides that the health and safety of the public will not be endangered by operation of the reactors.

How long will it take after a party initially applies for a license before that license is finally granted? On May 15 the AEC announced it was granting a construction permit to the General Electric Co. for the construction of a pilot atomic powerplant with a capacity of 5,000 kilowatts. That is just a baby. It would be even small in the rural electric program.

Once again the AEC only granted a construction permit and will not grant a license until final "hazards summary reports" are submitted and the Commission finds the final design provides reasonable assurance that the health and safety of the public will not be endangered by operation of the reactor. In this particular case the AEC granted a construction permit in a somewhat shorter time because the General Electric Co. applied only for a license January 10, 1956. But the AEC has not yet issued one license for the construction of a private atomic power reactor. How long must this civilian atomic power program be delayed?

Again engaging in the numbers game, the private companies brag about the tremendous expenditures being made by them for the construction of nuclear reactors. Some brag about a $300-million program. But what are the real facts about the amount which is being spent by private industry on the development of civilian atomic power? Admiral Strauss stated, as reported on page 344 of the hearings before this committee on February 29, 1956:

> Mr. Chairman, might I add just one word for the record. Dr. Davis and General Fields [both of AEC] tell me that the amount of money which they estimate currently is being expended this year by private industry in the power field will run somewhere between twenty and twenty-five million dollars. That is an earnest, it seems to me, of serious intent.

Senator GORE. What about a destroyer?

Mr. ELLIS. Yes. What about the 3- to 5-billion-dollar SAGE project? What about some of your generating plants now required in the TVA country that run many, many times this amount?

This is a very small investment compared with the total amount spent on new construction yearly in the utility industry. In the January 23, 1956, issue of Electrical World magazine, it is estimated the $3,906 million will be spent on capital expenditures by the electric-utility industry during 1956. Compare this with the 20- to 25-million dollars private companies are planning to spend during the same period on atomic power development and it becomes obvious that private industy isn't doing the job, it is only delaying it. Therefore, we believe it is absolutely essential for the Federal Government to fill this vacuum and get the civilian atomic power program going.

HIDDEN GOVERNMENT SUBSIDIES

The fourth reason why we believe the Federal Government itself should construct reactors of each major type as envisioned by the Gore bill is that many of the reactors which may be constructed privately will contain many hidden Government subsidies. In fact, in some cases we believe it will be more economical for the Federal Government itself to construct these reactors and also it will be much easier to measure the actual cost of generating atomic power. I think the Shippingport, Pa., pressurized water reactor is a good example of the use of one of these hidden subsidies.

According to page 66 of the Report of the Panel on the Impact of the Peaceful Uses of Atomic Energy (McKinney panel), the Atomic Energy Commission is contributing $32.25 million toward the construction cost of the pressurized water reactor being built in connection with the Duquesne Light Co. and Westinghouse Electric at Pittsburgh. The total construction costs for the reactor are estimated at $37.75 million. In addition, the Atomic Energy Commission is contributing $59.6 million toward the research and development phase of this reactor. Thus, out of a total cost for construction and research and development of $107.35 million for this reactor, the Commission is contributing, according to the McKinney panel report, $91.85 million or 85.4 percent.

In addition, and this is extremely interesting to us, of the $15.5 million of the Shippingport plant to be financed by the Duquesne Light Co. and the Westinghouse Electric Co., $10,500,000 has been certified by the Office of Defense Mobilization under TA28436 for a rapid tax depreciation certificate entitling the company to depreciate the conventional portion of the plant during a 5-year period. This amounts to an additional benefit in interest free loans to the company of $15.75 million over the 33-year period during which the conventional portion of the plant would normally be depreciated.

Senator GORE. That is a remarkable example of free enterprise, is it not?

Mr. ELLIS. Yes. Raiding the Federal Treasury.

Thus, with the Atomic Energy Commission itself contributing $91.85 million of the total $107.35 million cost of the project, and with the United States contributing an additional benefit of $15.75 million in the form of rapid tax depreciation subsidies, the Duquesne Light Co. and the Westinghoue Co. are contributing virtually nothing to the cost of this plant.

Also some of the private-power companies which are interested in the construction of experimental reactors have indicated that they want to writeoff their research and development costs as deductions from Federal income tax. Walker Cisler made this demand in his statement which appears on page 248 of the printed hearings before this committee on February 16, 1956. Philip Sporn, who I believe is in the room, president of American Gas & Electric Corp. and president of the nuclear power group, has also indicated that his group plans or may plan to do this. The following exchange took place between the chairman, Senator Anderson, and Mr. Sporn when he appeared before the committee on March 6, 1956, and appears on page 529 of the printed hearings:

Chairman ANDERSON. If profits were not reduced, would not the Government thereby be taking 52 percent?

Mr. SPORN. I believe that is right. I believe this: We are going to charge our research, Senator, what amounts to about $600,000 this year, to operating expenses.

Chairman ANDERSON. Will that not reduce your profits?

Mr. SPORN. This will reduce our profit by roughly $300,000.

Chairman ANDERSON. You mean profit after taxes or before taxes?

Mr. SPORN. After taxes.

Chairman ANDERSON. That is right. But before taxes you are reduced $600,000. I pay taxes, too, Mr. Sporn, although not as large as you do, but I know you pay income taxes on corporate profits.

Mr. SPORN. Yes, sir.

Chairman ANDERSON. If it reduces your profits $600,000, does the Government thereby not contribute 52 percent to the cost of this research, or are you in a different situation?

Mr. SPORN. To the extent that you subject yourself to additional operating expense, and therefore reduce your taxes by 50 percent of those expenses, that represents a Government contribution here, but that is true of everything that corporate enterprise does.

By the way, this is for the reactor which the private-power companies claim they are going to finance without any Federal assistance. Still they want to include their research and development expense as an income-tax deduction and also, there is some indication that later they may apply for a rapid tax amortization certificate.

Senator GORE. You mean they want their expenditures in this field considered for tax purposes as if they had made charitable contributions?

Mr. ELLIS. Yes. These are just some of the hidden subsidies which exist in the reactors being proposed by private industry.

USE OF AEC RESEARCH AND DEVELOPMENT

Also, these companies which claim that they are constructing reactors without Government assistance should acknowledge the fact that they are drawing heavily on research and development now being undertaken by the Atomic Energy Commission.

When Mr. Lindseth appeared before this committee as the representative of the Edison Electric Institute, he indicated that the Pennsylvania Power & Light Co., which is contemplating building a 150,000-kilowatt homogeneous reactor, will utilize research being conducted by the AEC at Oak Ridge. This is one of the reactors which is supposed to be financed without any Government assistance. Philip Sporn, president of American Gas & Electric Co., indicated that their nuclear power group would also use some of the research being undertaken by the Atomic Energy Commission but Mr. Sporn stated as reported on page 542 of the printed hearings before this committee:

We are proceeding with work [on our reactor] entirely as a privately financed undertaking without any Government contribution.

Apparently, these companies do not consider the considerable Government research which has and is being done and which will utilize a Government contribution. We believe it is a Government contribution and a rather expensive one and we believe for that reason every effort should be made to make available the technology developed by these private companies to as wide a group as possible. If they are going to draw on something which is actually a part of the public domain, we strongly believe that the information they develop should be available to all the people.

Further, almost all these private companies which are contemplating the construction of reactors have indicated that they will not construct them until the Government assumes the extraordinary liability risks which may be involved in the operation of these reactors. Mr. Willis Gale, chairman of the Commonwealth Edison Company of Chicago testified before this committee on February 16 and this appears on page 241 of the printed hearings:

The other possibility would be for the catastrophe risk to be assumed by the Federal Government. If reactors are to be built, this risk must be assumed by someone. The development of competitive nuclear power is in the interest

of all the people. Why not have the risk shared by all the people through the Federal Government?

Mr. Gale is also president of one of the companies which is participating in the proposed 180,000 kilowatt boiling water reactor, which they state will be constructed without any financial contribution from the Federal Government. Don't they consider the Government assuming a major part of the liability involved in the operation of such a reactor a contribution from the Government? This certainly would involve a considerable expenditure on the part of the Federal Government.

We do not dispute at all the need for the Government assuming such liability and we have so testified before this committee recently, but we believe these companies should be frank in stating their position and admit the fact that they are requesting large amounts of Government assistance through tax writeoffs, tax deductions, drawing on AEC research and development work and also asking the Government to assume the liability above that which is normally available for conventional generating plants.

DEVELOP YARDSTICK ATOMIC PLANTS

The fifth reason why we believe the Gore bill is an essential next step in the civilian atomic power program is that it would develop yardstick atomic plants. These plants would enable us to determine what the true costs of atomic power are. We may not be able to determine this from some of the private or partially privately financed plants which are now being constructed such as the Duquesne Light Co. reactor at Shippingport, Pa.

The competitive yardstick of our great Federal power projects have always been a means of measuring the cost of private development. It has resulted in decreased cost and increased efficiency in the whole electric industry. One only has to remember the competitive effect of the TVA plant at Paducah, Ky., as compared with the private powerplant which was also being constructed to serve the AEC at Joppa, Ill. The two plants were constantly being compared as to cost per kilowatt and the time it took to complete them. We believe that such competition is a healthy thing and this is one of the greatest benefits which will be derived from the Gore bill.

Also, if these plants are completely federally financed there will be no question but that the technology developed from them will be available to all those who can make use of it. I believe there is a serious question as to whether or not this will also exist in the privately or partially privately financed reactors. In fact, in the winter 1956 issue of the Duke University Law Review on atomic power development, Mr. Delbert M. Leppke who is assistant technical director of the nuclear study group of the Foster Wheeler Corp., in an article entitled, "The Facts of Atomic Power Development: Some Aspects of Nuclear Power Economics," states:

> Therefore, perusal of the estimated capital costs of these first plants may be misleading unless one has some estimate of the development costs included and a measure of the amount by which they may be decreased as subsequent plants are built. These data are difficult to obtain, however, since their determination is governed by internal company policy and since changes in reactor technology are occurring so rapidly that no concise approach to the proration of developmental costs can be formulated at present.

I do not believe that internal company policy should impose a secrecy curtain beyond which those who can benefit from the use of atomic power information can't obtain it. This might have some justification in a situation where a company would finance atomic-energy research and development without any Government assistance whatsoever, but such a situation is very hard to imagine because almost every company will have to draw to some extent on the $15 billion which the Government has already spent on the development of atomic energy. We believe that this technology can be developed more expeditiously if the research and development work that takes place becomes part of the public domain and is made available as widely as possible to those who make a contribution to the advancement of this new technology. It would enable those who are able to make a contribution to the advancement of the art to do so, it would not restrict this development to a few large companies who may have been able to contribute some money to the development of reactors.

We believe some of these Federal yardstick atomic plants can be built in areas where the Federal Government is now using a large amount of the available power supply for defense purposes. Of course, the Federal Government has first call on this power for such purposes and the more of it the Government uses, the more it is taking away from the power supply needed to meet the constantly increasing civilian needs.

For instance, in the Tennessee Valley the AEC and other defense requirements are now consuming about 50 percent of TVA's power generation. According to TVA, there is very little prospect of any letup in this situation in the next few years. Also, in the Northwest AEC is using huge amounts of Federal power. We believe that in these areas as well as in the very-high-cost areas such as New England, the north-central part of the country, and some parts of the Southeast, demonstration reactors such as envisioned by the Gore bill could be utilized right now.

I know the Congress or AEC would have no difficulty in finding locations for as many reactors as Congress authorizes and directs the AEC to build.

The use of power in the United States is so important as related to our total energy supply since the use is doubling every 7½ to 10 years and has been for several decades. There is no major American industry growing as fast as the power industry. These reactors could be located in any part of the country and the power could be used almost immediately.

But we are not sure that this bill should be limited to six different reactor types because many other types might be developed or identified in the future and it might be necessary also for the Federal Government to undertake the development of these reactors because of the unwillingness or slowness with which private industry approaches the problems.

Senator GORE. I have some doubt, too, that six would be sufficient, but I think it is a good start.

Mr. ELLIS. Yes; we do, too. We would be happy to see one, but we think there ought to be several more than that.

There is no question but that yardstick plants will result in reduced power costs.

Senator GORE. I should have added that in studying this whole question that it appeared to me that there were at least six processes or designs—distinctive processes and designs—which offered great promise for development; at least six major geographical areas in the country with some distinctiveness of problems within themselves. So I suggested in the bill six. Maybe it should be eight. Maybe it should be five. Maybe a better argument could be made for 5 or 6 or 7 or 8, but whatever the number may turn out to be as a result of study, the most important thing is to get this program started and get it started quickly.

Mr. ELLIS. I understand and I understand it to be common throughout industry, Senator Gore, that companies usually know of improvements which could be made in their products but which they do not put into effect immediately because of their investment in the product which is in demand as of today. I understand, for instance, that General Motors is working on plans for automobiles for several years ahead but they don't stop this year's production and wait until they are ready with these other plans before going ahead.

There is no question but that yardstick plants will result in reduced power costs. Let us take a quick look at what has happened to the Tennessee Valley and also in the Northwest to see the effect of such yardstick competition. Attached at the end of my statement you will find chart A, which shows the average price of power purchased by REA borrowers, fiscal year 1952. You will note how the price increases the further one goes from the Tennessee Valley area and also from the Bonneville area.

This shows the power rates paid, average price of wholesale power purchased by REA borrowers, fiscal year 1952.

You will note the lowest price paid in the eastern part of the United States is in the Tennessee Valley itself where our systems are paying an average of 4.9 mills per kilowatt-hour for power. Note what happens immediately around there.

In the South within a radius of 200 miles or so the average wholesale power cost is 6½ mills. To the north in that same circle it runs about 9 mills. In the next 200 miles out, it jumps in the south to 6.6 mills, then in the next concentric circle to 6.9 mills. No north, it jumps from 9.3 mills to 12.2 mills, and then as one gets further from TVA it jumps from 12.2 to 13.8 and 13.8 to 15 mills. If you move on out West in the Bonneville area we are paying 3½ mills. Start moving further away from that area and you have 5.8 mills, 6 mills, 8.4 mills. This is not absolute because there are other areas of the country where there is Federal power coming on and these rates are changing.

But the effect always is to reduce the rates not only in the area of the Federal power but for some distance around those areas.

Furthermore, such competition does not adversely affect the financial structure of the private power companies. They just lower their rates, sell more power and increase their profits. To illustrate this, I have attached chart B at the end of my statement which shows the trend in power company common stock earnings for the power companies which are contiguous to the TVA area. You will note that the earnings of these companies increased at a faster rate than the power companies in the rest of the country. Again because they lowered their rates, the use shot up and with greater use came greater profits.

Senator GORE. Do you mean to imply that TVA encouraged its neighbors to engage in volume merchandising of power?

Mr. ELLIS. Yes, sir. It brought to bear among other things the economies of large-scale production which shot those profits up because of greater use.

Therefore, we believe private industry will actually benefit from the construction of Federal yardstick plants. They might also benefit because the yardsticks would give them too, a better idea of what the cost of atomic power, in the different ttype plants, would be. It would provide the element of competition necessary to hold down nuclear power co-ops which would result in lower rates to the ultimate consumer. We must get on with this Federal yardstick atomic power program as quickly as possible. We must show the rest of the world that we can develop these plants efficiently and quickly and by this example prove to the rest of the world that once again the United States is out in front in the development of a new technology.

GORE BILL IS ANTIMONOPOLY

The sixth reason we believe the Gore bill is essential is that it would broaden the base of participation in the atomic-energy program and discourage monopoly. We believe that too much of what little atomic-energy program we have to date is being carried on by large private industry. This may be necessary to a certain extent because large private industry has the manpower and financial resources to participate in this program. But at the same time we think it will be a national tragedy if small industry which is interested in getting into this program and is competent in this field, is denied the opportunity to do so. This will do nothing but strengthen monopoly in the development of what may be one of our most important sources of power a few years from now, unless some such program is started.

I think Mr. John Menke, president of Nuclear Development Corporation of America, White Plains, N. Y., in his testimony before this committee on March 5, which appears on page 469 of the printed hearings, sums up the problem:

> A difficult dilemma is often posed for the Atomic Energy Commission and its contracting officers by the vigorous competition between large and modest-sized companies. The dilemma is more difficult because of the very large size, single-unit costs for reactors and their development.
>
> On the one hand, the large corporations can make substantial dollar contributions from their diverse businesses, can accept large dollar risks and take losses, can provide large facilities and have large staffs. These big companies do make important contributions, although sometimes (with the larger staffs needing longer times for education) they may tend to move rather slowly.
>
> On the other hand, companies that are modest sized at present may have large accumulated specialized experience and background with an integrated competence. They may have a distinct originality, and they are usually characterized by a capability for speed which has much importance when the lead time of the United States is kept in mind. It must not be forgotten that these modest-sized companies, along with the big companies, also make important contributions to the progress and strength of the United States.

We believe that a reactor development program which is financed by the Federal Government should give these smaller companies more of an opportunity to get into this field, especially if AEC is to avoid monopoly and to broaden the base of participation. Likewise, we feel that this would afford a better opportunity for more of our rural

electric systems to participate. If they want to participate, they should not be under the pressure they now are having to assume considerable risks when they do not have any risk capital. We believe the Gore bill would hasten the day when the elements of atomic power are brought to the farm families of America.

INCREASED APPROPRIATIONS NECESSARY

The final reason why we support the Gore bill is that we believe that it would give an incentive to the administration to increase the appropriations for the civilian power reactor program. We believe the present budget is entirely inadequate for that purpose. It is incomprehensible to me that, with other countries moving out in front in atomic energy development, the total Bureau of the Budget request for appropriations for the AEC for fiscal year 1957 of $1,672 million only $38,156,000 will be applied to our country's stalled civilian power reactor program. We believe that vastly increased emphasis should be given to the development of civilian atomic power now. This program will go ahead on a more rapid basis only when the AEC is actually authorized and directed to construct reactors to further the technology and only when AEC is directed to comply with the intent of the Atomic Energy Act of 1954 and establish a real civilian atomic power division. We cannot expect small staffs which are occupied primarily with pressing military needs to devote the necessary time and effort to a real civilian atomic power program.

It seems a shame that the country which has developed supremacy in atomic weapons is losing the fight to develop civilian atomic power not only for ourselves but for the whole world. Civilian atomic power means to the underdeveloped countries new hope for a more abundant life. If we cannot help them to make atomic power available to themselves, we may find ourselves in a worsened international situation in spite of our large stockpile of atomic weapons.

We agree with Commissioner Murray that the Federal Government should construct atomic powerplants here and abroad that would be capable of generating a total of 2 billion kilowatts of power by 1960 and a total of 10 million kilowatts between 1960 and 1965. In order to finance such a program, Commissioner Murray suggests that the Government spend $1 billion per year for the first 5 years in addition to the regular AEC budget. This is by comparison with the present budget of some $38 million for the civilian power reactor program. We believe with the authorization of the Gore bill and the foresight of the Congress this present inadequate budget for the development of civilian atomic power should and would be greatly increased and that it would very probably save our taxpayers much money in the long run.

CONCLUSION

Once more may I repeat that we are greatly disturbed by the vacuum which exists in the development of civilian atomic power in the United States. We must do everything we can to fill this vacuum and get this program off of dead center. We cannot wait a period of several years to see whether the private power companies get all their conditions and contingencies satisfied and then proceed toward the development of

an adequate civilian power program. We must embark on such a program now and on a much larger scale than ever before. We believe the way this can be done is through the authorization contained in the Gore bill. We must rise to the challenge—create an atomic abundance at home and meet the international competitive atomic power threat wherever it raises its ugly head.

If our Atomic "Energyless" Commission will not move, we the people and the Congress must move it. AEC has been sitting on its immovable bottom insofar as civilian atomic energy is concerned, for more than a decade now basking in the halo of its weapons program. I personally believe it should be abolished and a new and expanded Atomic Energy Commission created—or at least that all duties and responsibilities in the civilian atomic energy field be transferred to a new dynamic agency.

Chairman ANDERSON. Thank you very much.

I just checked Commissioner Murray's testimony. It was 2 million kilowatts. We will leave it that way unless you desire to have it changed.

The next witness is Mr. Sporn.

Mr. ELLIS. Mr. Chairman, may I comment just briefly on one other thing. There has been a lot said here about preference and how that would be in the way. I just learned that.

Chairman ANDERSON. Not much has been said. Some has been said about it.

Mr. ELLIS. We think that is not in the way anywhere. We think it is truly a long-established American practice and policy and it ought to be retained in whatever legislation is enacted with regard to plans to be developed by the Government.

(The charts referred to by Mr. Ellis, follow on p. 281–282:)

Chairman ANDERSON. Mr. Sporn, we are very happy to have you with us today. I made a comment earlier with reference to the Portsmouth plant or the OVEC plant which I thought I had just seen some announcement that it had beeen completed and a saving on the original was two or three hundred million dollars.

Am I not referring to an enterprise with which you have been identified?

STATEMENT OF PHILIP SPORN, PRESIDENT, AMERICAN GAS & ELECTRIC CO., PRESIDENT, NUCLEAR POWER GROUP, INC.

Mr. SPORN. There have been a lot of savings but not that much. The project was originally estimated at $440 million maximum and came out at actually $380 million. The project is in commercial operation.

Chairman ANDERSON. I am sorry. I know now that I am in error. I was talking about the Peter Kewit contract for the entire plant.

Mr. SPORN. Yes, sir.

Chairman ANDERSON. And I tried to tie to that the operations that you people did to supply current for it. In the 2 operations I think the saving has been nearly $400 million.

Mr. SPORN. It could very well be, sir.

AVERAGE PRICE OF POWER PURCHASED BY REA BORROWERS
FISCAL YEAR 1952

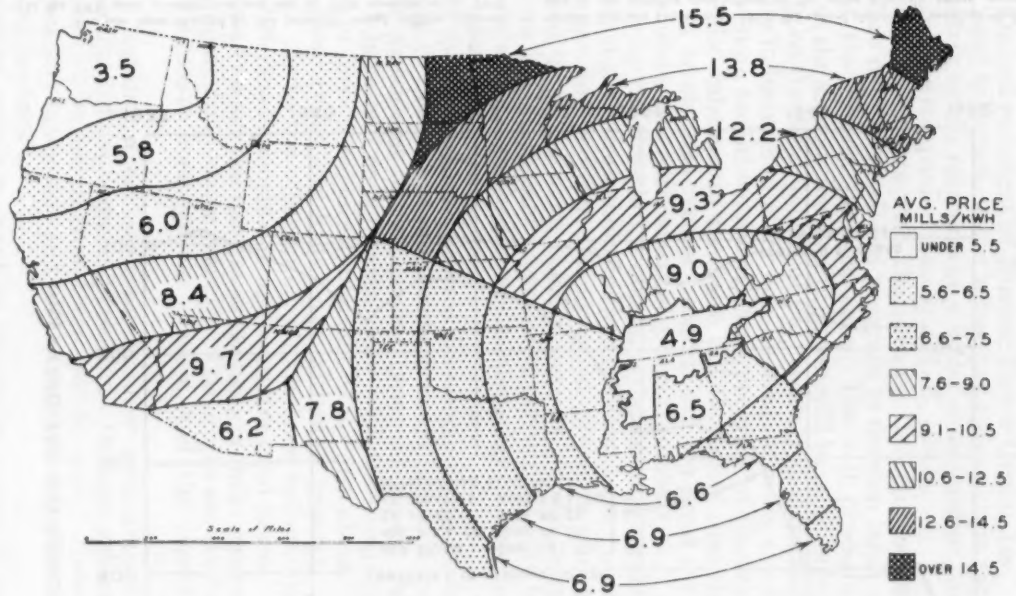
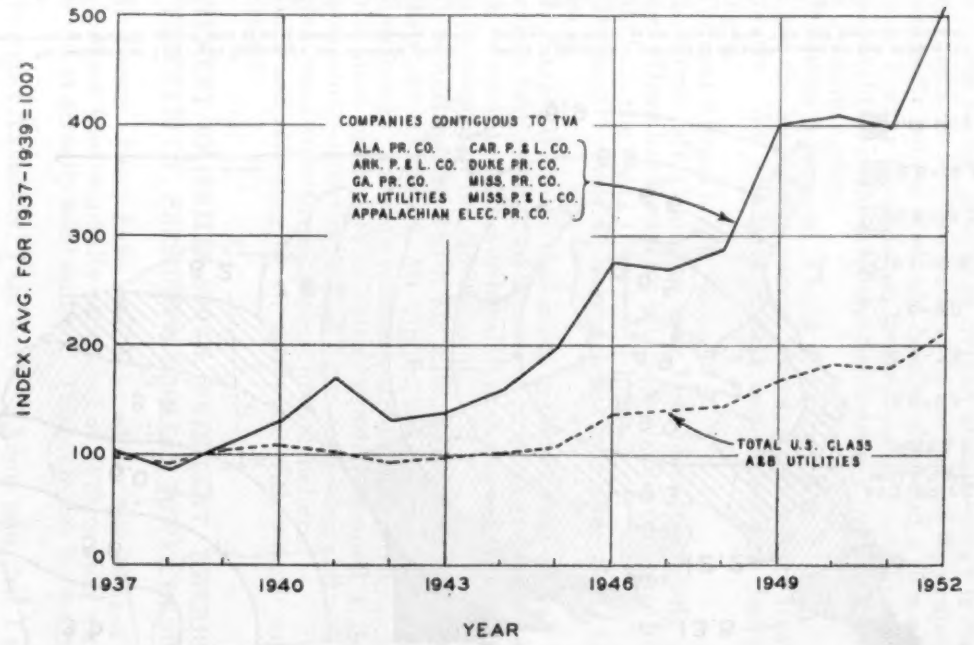


CHART A

The influence of TVA's and Bonneville's low wholesale electric power rates on wholesale electric rates to rural electric cooperatives elsewhere in the nation is indicated by the average price per kwh which grows progressively higher as the distance from TVA and Bonneville increases.

SOURCE: Tennessee Valley Authority, TVA's Influence On Electric Rates, page 6

TREND OF POWER COMPANY COMMON STOCK EARNINGS



The low rates charged by the privately owned utilities adjacent to the TVA area, whether they are low by TVA example or by TVA competition, have not retarded the growth in the companies' common stock earnings. From 1937, the earliest year for which Federal Power Commission data are available, to 1952, the record shows that earnings available to the common stockholders of the larger privately owned power companies in the United States a little more than doubled and similar earnings of the companies adjacent to TVA increased fivefold.

SOURCE: Tennessee Valley Authority, TVA's Influence On Electric Rates, page 7

Chairman ANDERSON. We appreciate your coming here and making a contribution at this time as you have very frequently before this committee.

Mr. SPORN. Thank you, Senator.

My name is Philip Sporn. Although I testified before this committee slightly over a week ago on the subject of indemnity and insurance, I want to place on the record the fact that I am appearing today, as on the last occasion, in my capacity as president of American Gas & Electric Co. and president of Nuclear Power Group, Inc.

I also want to record, at the outset, my appreciation for the invitation to testify on the measures now under consideration, the Gore bill, S. 2725, and the companion measure, H. R. 10805.

The Gore bill starts with the premise that our national prestige and welfare require an all-out program to develop large-scale atomic power at the earliest possible date. The bill proceeds from this premise to the assumption that progress will be more rapid if, instead of relying on the development of the necessary demonstration projects by private industry and other non-Federal interests, the Government embarks on an ambitious construction program of its own. There is perhaps also inherent in the Gore bill the belief that the costs and risks of an accelerated reactor program are too great for private industry to undertake enthusiastically and vigorously.

Underlying the Gore bill, I take it, is the assumption that if specific construction goals are established and sufficient money provided by the Government for projects, the technical problems will somehow be solved and be solved more rapidly than by purely private projects, or by work in Government laboratories carried out only to the prototype stage, as distinguished from the later stage of major large demonstration plants.

Rather than to go into a general discussion of this problem and the expression of categorical judgments, I would like to discuss the issue from the standpoint of five reactor types. I choose this approach because I have had enough experience with these particular reactor concepts to form a technical judgment of my own about them. As to two of these types, my knowledge, although general, is, I believe, accurate. As to the other three, I have been rather intimately connected with developments during the past several years.

The first two are the natural uranium, graphite, gas-cooled reactor and the pressurized water reactor. The others are the boiling-water reactor, aqueous homogeneous reactor, and the liquid metal fuel reactor.

Taken together, these five reactors cover a significant part of the total spectrum of development problems. Perhaps general inferences can, therefore, be drawn from these specific cases. However, I leave that possibility to one side and will concentrate my discussion on these particular reactors.

The natural uranium, graphite, gas-cooled reactor is exemplified by the famous Calder Hall plant now nearing completion in Great Britain. It is planned as one of a series of the same type for British construction. Parenthetically, I should perhaps point out that, during the last 5 years, I have made 3 trips to Great Britain to see what they are doing in the power field—both conventional and atomic. I have talked with the responsible British authorities on many occasions,

both in England and on their visits to this country, and I have kept up with the authoritative literature. I believe, therefore, that I am fully informed on what the British are doing and the reasons for what they are doing.

Calder Hall has probably fewer technical problems than any reactor that is being proposed today for the commercial-scale generation of electric power. But it has many disadvantages. It has the disadvantage of size. It takes up much more cubage—and therefore involves higher costs—than the reactors that operate on enriched fuels. It has the further disadvantage that, in the transfer of heat, it utilizes a gas-to-gas transfer surface which is extremely inefficient from an engineering material—and therefore a capital cost—standpoint. We found this out in our study of analogous circuits in connection with the gas turbine.

For Great Britain, however, the choice of this particular reactor for its first series seems natural and wise because of the critical situation that is confronting the British on fuel. The British are finding it difficult to obtain the necessary coal and oil to take care of their growing energy requirements. Rather than run the risk of subjecting the entire British economy to a critical energy shortage, they have started their reactor program on the most conservative of bases. Foremost in the British thinking has been the necessity of building reactors that can start to work successfully almost from the first day they go into operation. In this way, the Calder Hall plant and the others patterned after it can, from the outset, carry a share of the burden of the British energy needs through uranium and thus ease the burden on coal and oil.

Chairman ANDERSON. I believe the British said publicly the reason for their choice was the factor of safety. Do you have reason to doubt that?

Mr. SPORN. I believe that is one of the reasons. There are several other reasons. One of the reasons, too, is that they do not have any gaseous diffusion plants they can use to produce enriched fuel so they can't spare the material.

I think safety, Senator, is one of the reasons from the standpoint that they have to get going and start producing power. A shutdown of 6 months, which is not at all unusual even in conventional powerplants where they are out in the forefront, is something that the British cannot tolerate. The British have a critical fuel situation.

I have discussed that at great length with the foremost people in Great Britain.

As the Senator perhaps knows, within recent years they have entered into a contract for the shipment into England of 10 million tons of oil per year over a 10-year period. Five million tons from Shell and 5 million tons from Esso Standard, and the reason for that is because the British mines are not producing enough coal to take care of the British requirements. We all know that there was a time not so very long ago when Britain was the principal supplier of Western Europe with its fuel requirements through the export of coal. But that situation has changed and changed in Great Britain. Britain is an industrialized country and has to have additional energy, and they see, in putting the atom to work immediately, a way out of the very critical fuel situation.

Incidentally, in discussions with some of their people on this question of economics, the observation they made to me was something like this: "It is not really a question for us what it is going to cost us. It is a question of whether we are going to have it."

I believe that, too, is the case. I believe that what the British are doing is just right for Great Britain and I think is a very farsighted piece of technical and economic judgment and statesmanship to take care of the British economy.

We do not have a fuel crisis in the United States. We do not need to confine ourselves to natural uranium because the great physical-chemical operations at Oak Ridge and Portsmouth give us ample supplies of enriched uranium which the British do not have. Hence, it is not surprising that there is no proposal in the United States for development of this type of reactor. It is clear to me—and I would hope it would be clear to the committee—that there is no need for us to spend our resources of manpower and materials to build reactors of this kind which, in my opinion, will not, in the long term, be efficient power producers.

The pressurized water reactor is a more advanced reactor design. As the committee knows, this is the reactor successfully used in the powerplant that drives the U. S. S. *Nautilus*. The pressurized water reactor is a type that the British propose developing in a second phase of their program not yet commenced. But this reactor in large sizes has already great momentum of development underway in this country. Shippingport, I am reliably informed, will be completed and producing power sometime in 1957. Consolidated Edison's construction schedule on its pressurized water reactor, which is to use thorium as a principal fuel element, calls for the commencement of major construction at Indian Point next spring, and it is hoped to have the plant in operation before the end of 1960. Yankee Atomic Electric Co. is undertaking a third variation of the pressurized water reactor using a different type core. I am sure that, because of the development work on the pressurized water reactor that is already underway, other projects of this species are bound to come into being without any extraordinary efforts on the part of the Government.

I come now to the boiling water reactor. I have discussed this reactor on two previous appearances before this Committee. Mr. Willis Gale, president of Commonwealth Edison Company, and Mr. Frank McCune of the General Electric Company, have both testified on a number of occasions about various aspects of this reactor in connection with the Dresden project. Commonwealth Edison is installing a 180,000 kilowatt boiling water reactor plant at Dresden, with the General Electric Company as the prime contracting agency. When I testified here on March 6, I pointed out that the boiling water reactor was the next logical step after Shippingport in building large-scale reactor demonstration projects. It represents the next logical step because the state of our current technological knowledge gives us confidence (1) that it can be brought into practical operation, and (2) that it affords a reasonable expectation of advancing the atomic industrial art further along the road toward commercially competitive atomic power. Comparing Dresden, for example, with Shippingport, the Dresden plant will make possible higher pressures and higher temperatures and other features in the use of materials for heat-trans-

fer purposes which can bring about economies in the generation of steam to propel a turbine. These savings will show up in the ultimate cost per kilowatt of capacity and in the ultimate cost per kilowatt hour at the switchboard.

Mr. McCune has already given you an extensive account of the status of the Dresden project and has shown you a series of photographs of the actual work accomplished. In my testimony before this committee on May 17, I reported that, by the end of this year, Commonwealth Edison will have invested $6 million in the project and Nuclear Power Group will have paid in an additional sum of $3 million to bring the project into being. In addition, Commonwealth Edison will have spent in the neighborhood of a half million dollars for site and acquisition costs so that there will have been spent very close to $10 million by the end of this year. Ten million dollars, in my judgment, is a great deal of money and cannot be anything else but the most earnest kind of demonstration of the faith of the participating companies in the soundness of the project and the desire to move it along just as rapidly as possible. Quite obviously the money expended, until such time as the reactor goes into operation, is not productive and the sooner the project can be brought into operation, the sooner the capital can be brought into productive use.

The 22,000-kilowatt boiling-water reactor proposed to be built by the Rural Cooperative Power Association of Elk River, Minn., will use another variation of the boiling-water reactor concept. Compared with the 1,000 pounds pressure and 545° F. temperature of the initial steam conditions of the Dresden reactor, Elk River proposes to drop pressure to 600 pounds but, with a separately fired superheater, to raise the temperature to 825° F.

The momentum that is being rapidly picked up in connection with these design concepts is such that additional reactors of this type are bound to come along, each of which should be another step forward along the road to commercial atomic power. Here, too, I believe that it is quite clear that the momentum of the development is such that no further acceleration is necessary at this stage in the form of Government built reactors.

Now I come to what are certainly the two most advanced types of reactors that I have been associated with and which, in my judgment, are the most exciting from the standpoint of their promise in leading to commercially competitive atomic power. I am referring to the aqueous homogeneous reactor and the liquid metal fuel reactor.

The reactors that I have described up to now are all of the so-called heterogeneous variety. All of them utilize fuel elements set in a lattice or frame of the moderator. The fuel elements are one of the most technically difficult part of the job in these reactors. These elements generally are made of uranium but they could be made of uranium alloys or uranium compounds. They frequently have to be designed and built with very fine dimensions and tolerances. When subjected to radiation they change form and the problem arises of keeping them in the reactor once deformation has taken place. And, of course, fuel elements have to be replaced as the number of fissionable atoms are used up and as poisonous byproducts form and slow down the reactor. Reprocessing of fuel is an expensive operation.

All of these problems become less serious in a homogeneous reactor where the fuel is in a solution. The aqueous homogeneous reactor is

one that nuclear power group has been studying for a long time. When, on March 31, 1955, Commonwealth Edison, on behalf of itself and of nuclear power group, made an application to the Atomic Energy Commission for a license to proceed with the building of the heterogeneous boiling-water project at Dresden, it did so only after carrying out an extensive study of both the aqueous homogeneous reactor and the boiling water reactor.

Senator JACKSON. I would like to ask this general question. I hope you will forgive me for interrupting, Mr. Sporn, but I have to go to another meeting.

Are you satisfied in general with the present program?

Mr. SPORN. I have not finished my statement, Senator, and I prepared this or did the last work on it Tuesday night and then left town and was in Ohio and Indiana during the following 2 days and I got back very late last night. I missed the testimony that was given here during those 2 days and actually I had a chance to look at it only this morning. Some of the things in that testimony bother me. There were points raised that I perhaps had not considered enough, particularly some of the points made by Dr. Smyth and by Dr. Zinn.

Senator JACKSON. Especially on the natural uranium approach. I have great respect for you. You are one of the few witnesses from the private utility industry that comes in technically qualified.

Mr. SPORN. Thank you.

Senator JACKSON. You are a great engineer and have a lot of ability not only as an engineer but as an executive. I wondered because of of the testimony of Dr. Smyth and Dr. Zinn, who are very competent people, I know you will agree——

Mr. SPORN. Yes, I have very high regard for both.

Senator JACKSON. They suggested this natural uranium course which was a suggestion made after the preparation of your statement.

Mr. SPORN. Yes. I was not aware of any part of it when I wrote this statement that I have been reading right now, Senator. I would say this. My own judgment is that natural uranium from the standpoint of our problem in the United States is not particularly an attractive proposition. I don't see anything to get excited about in pursuing a program of reactor development using natural uranium elements. I think, however, from the standpoint of our international situation and the international problems and politics, if you will, the commitment that we have made to the free world in particular, there may be reason for taking a better look at natural uranium than I was inclined to believe when I wrote the testimony that I have just read, Senator.

Senator JACKSON. When you prepared your statement you did not have the benefit of the views that were to be later suggested by Dr. Zinn and Dr. Smyth, and I think Mr. McCune from General Electric said that they are still interested in that approach.

Mr. SPORN. I certainly would like to give that matter some additional thought. I have some ideas on that.

Senator JACKSON. I think it might be well, Mr. Chairman, if Mr. Sporn could file a supplemental statement later in connection with this hearing.

Chairman ANDERSON. We would be very happy to have it. It struck many of us that because of our international commitments and because of the fact that we had announced we were going to send so many

kilograms of uranium and have it available for all the earth, Senator Pastore pointed out it is not much value unless there is a reactor to put it into.

(The material referred to follows:)

AMERICAN GAS & ELECTRIC CO.,
New York, N. Y., June 4, 1956.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
United States Senate, Washington, D. C.

DEAR SENATOR ANDERSON: In the course of my testimony of May 25 you invited me to file a supplementary statement, if I so desired, relating to certain questions raised by you, Senator Gore, and Senator Jackson.

I would like to accept your invitation to the extent of making further comments on three points:

1. The first point relates to the question whether, in my judgment, it would be desirable for us to build a reactor using the natural uranium, graphite-moderated approach followed by the British. As I indicated in my testimony, it is my belief that the present program of reactor development in the United States is, on the whole, sound from the standpoint of our domestic requirements, and at the same time well designed to assure us the leadership necessary to assist friendly countries abroad. I feel that this will particularly be the case when we get into operation some of the smaller reactors that are part of the program in the 10, 20, and 40 mw class.

With our existing program for large plants, the second demonstration program for powerplants useful in power systems that at present cannot use the larger size units, and the AEC pilot plant program for more advanced plants, we have an overall program that covers a wide concept of possible reactor developments, as well as a wide concept of power system needs insofar as size of units is concerned. In short, if we have reasonable success with the private and other non-Federal projects already proposed and the projected AEC pilot plants, we are likely to have available, as rapidly or more rapidly than anyone else in the world, a selection of power reactor concepts that can fulfill any requirement here or abroad, provided it is a requirement that a nuclear plant can reasonably fulfill.

It is possible, however, because of the attractiveness of natural uranium to foreign countries, where uranium enriching installations are not available, that reactors utilizing natural uranium would have special attraction for them, in spite of their economic handicaps. Perhaps, therefore, such a reactor combining both natural uranium and graphite ought to be more fully explored by us. If such investigation yields promising results, then arrangements for having it built ought to be made. However, this question cannot be answered categorically without a considerable amount of additional exploratory work, both technical and analytical, and a careful evaluation on the basis of such work.

2. The second point relates to the question raised as to the general adequacy of the present program, not only from the standpoint of whether we ought to explore a graphite-moderated, gas-cooled reactor, but also from the standpoint of whether we are adequately covering the entire waterfront of promising reactor concepts. On the whole, it appears to me that the program we have is well designed to achieve the objective of maintenance of world leadership, but I also agree that no one can say with certainty that every reactor that deserves careful consideration has already been given such consideration or is being pushed as fast as it deserves to be. Nor can anyone say with certainty that a particular reactor concept, once passed over as unpromising, should not be looked at again in the light of present developments with a view to making sure that everything worth exploring is being properly explored.

But the question of the general adequacy of our reactor program in scale, scope, and timing cannot be disposed of soundly just by discussion among laymen. In the end, of course, members of the Congress, AEC Commissioners, industrial managers and others, who are essentially laymen, should decide these issues. But, in order for their decisions to be made wisely, they must be made upon the basis of the best informed and most expert technical evaluation possible of the progress that is being and can be made.

3. This brings me back to the suggestion I made in colloquies with you, Senator Gore and Senator Jackson in the course of my testimony: That is the suggestion for the setting up of a high-level technical evaluation group to provide the Commission and the Congress with a comprehensive technical basis for their diffi-

cult decisions. My thought is that the group should report to the Commission periodically on its investigations and findings with regard to reactors and reactor development. I have in mind that such a group could be assigned the task of investigating and reporting on such matters as: the status of the current program; the results achieved to date; the difficulties and failures encountered; the positive experiences with better behavior or performance than originally anticipated; the significance of all these in terms of the current program and on the further projection of the program; to the extent possible, analysis of the results in the principal foreign centers of reactor technology development; and, finally, recommendations for action involving further expansion of the existing program, acceleration or retardation of certain parts of it, and initiation of new projects.

In my view, the overriding emphasis in selecting members for such an evaluation group should be technical competence. The group would need a substantial number of members from the power industry; and the topflight engineers that I would seek can be found both among the public and the private power systems. But I think we have got to avoid treating this as a public versus private power question. The evaluation group would have to be composed of men with a background of sufficient general experience to treat the relevant questions in the technical terms that will provide the illumination of the Commission and the Congress need in forming their own judgments. Also, as indicated in my testimony, the technical evaluation group would have to have topnotch scientists among its members. And since our manufacturers have done and are doing such important work in the field, we need to look also to them to supply some of the important technicians who would constitute the evaluation group. If such a group, composed of widely gauged technicians, made periodic reports to the Commission, based upon solid investigation and analyses, the Commission could, in my opinion, have a much better basis for programing reactor development than it now has and the Commission, the Joint Committee, and the country would have a much more substantial assurance that the interests of the country in this vital area of action were being properly advanced.

Yours sincerely,

PHILIP SPORN.

Mr. SPORN. That is right.

Chairman ANDERSON. It might be that we would find some type of reactor where these other countries might find something of greater value to their present program.

Mr. SPORN. I don't care how simple we make the reactor, it will be complicated enough for most of the smaller countries we are going to try to help. The less complicated we make it, that means generally the less advanced it is, probably the more nearly they will come to being able to use it. I would like to give that some additional thought.

Chairman ANDERSON. I wish you would.

Mr. SPORN. I had discussed this primarily from the standpoint of our own situation. That is the viewpoint I expressed here.

Senator JACKSON. I think it would be helpful if he deems it wise to submit a supplemental statement which would be included in the record.

Chairman ANDERSON. We are inviting you to submit additional views and send us more if you would like to do it.

Mr. SPORN. I would be very happy to take advantage of it. Thank you.

Senator JACKSON. Thank you for the interruption. I have to go back to another meeting.

Mr. SPORN. Returning to my statement: We had wanted to start with a commercial size demonstration project on the homogeneous reactor principle; but our conclusions, at that time, were that a great deal more laboratory work needed to be done before any large-scale project of this type could be undertaken. As the committee knows, a number of these small aqueous homogeneous reactors have been built. The

first was at Los Alamos in 1944. The first homogeneous reactor to produce power, known as HRE–I, was built at Oak Ridge and operated from 1953 to 1955. In 1955, it was dismantled to make way for HRE–II and this reactor, designed to produce between 5,000 and 10,000 kilowatts thermal power, is now nearing completion.

Although we in Commonwealth Edison and NPG decided to go ahead with the boiling water project as our first plant when we made our application to the AEC in March 1955, we did not drop the idea of the more advanced homogeneous reactor. In November 1955, a special team of 10 NPG engineers undertook a 1-year study of the aqueous homogeneous breeder reactor in cooperation with Babcock & Wilcox. B. & W. has eight engineers assigned full time to this job and all of the specialists of that company are available when needed.

Chairman ANDERSON. That raises the question we had up the other day. What does happen to this second choice? Does it lie dormant as the gas-cooled type did that was supposed to be built in 1944 or soon thereafter at Los Alamos, or does somebody go ahead with it even though one group takes a different route? Obviously you are not going to build them both right away. Should someone test still further by the construction of a fair-sized power unit?

Mr. SPORN. I think if it is an interesting and exciting type that is likely to give a better result it certainly should be built, Senator, and I would hope it would be built.

The Oak Ridge National Laboratory development of this reactor concept has the reactor fuel solution housed in a thin core vessel and this vessel is surrounded by a second heavier vessel. The space between the two is occupied by the fertile breeding blanket material in a slurry form. A slurry is a finely divided solid suspended in a liquid. The problem of core vessel corrosion and slurry stability are proving to be very difficult to solve.

AEC's Reactor Development Division has asked industry to assist in the evaluation of other concepts of this homogeneous reactor type and that is precisely what the NPG–B. & W. study team is doing. We have adopted as our objectives the following:

1. Devise a reactor concept that, if possible, circumvents the major problems of the Oak Ridge design.
2. Set the requirements for plant availability on the basis of electric power system operating principles, which are rather rigid.
3. Design the plant components and component containment to simplify maintenance.
4. Visualize maintenance practices and their effects on plant availability and estimate their costs, including the required tools for handling inherently radioactive plant components.
5. Estimate kilowatt-hour costs on a realistic basis.

At this stage of our study, we have developed a reactor of unique design in which the core tank and the slurry have been eliminated. A reference design has been developed. Detailed engineering of the reference design components is in progress. Power arrangements are being prepared to minimize the disadvantages in maintaining a reactor system in which the fuel is in solution.

It is possible that, out of the work that is being done at Oak Ridge on HRE–11 or out of the work that the NPG–B. & W. group is doing, sufficiently encouraging results will be obtained to warrant a large-scale demonstration project. The committee, too, is aware of the development work on the homogeneous reactor which Pennsylvania

Power & Light Co. has underway in collaboration with Westinghouse Electric Corp.

So far as NPG is concerned, it is not possible for me to say at this stage what we will be able to do on a demonstration project involving the homogeneous concept. I do believe that, just as soon as laboratory work indicates that such a project makes any kind of sense, the entire group will seriously consider it with a good prospect that, somewhere among the group, or among the group with new members brought in, such a project will be brought into being. Under these conditions, again I doubt that anything more need be done at this time to stimulate demonstration developmental projects of this type. What we need is to proceed in the laboratory with the experimental work and prototype work and to hope that the difficult problems that still remain to be solved can be surmounted.

Chairman ANDERSON. Could you give us some idea of the amount of money the study group is spending on this sort of work?

Mr. SPORN. I think we are spending about $200,000 a year at this time. B. & W. is spending almost as much money.

Chairman ANDERSON. Is this laboratory work?

Mr. SPORN. We have quite a staff, yes, sir. It is mostly analytical and visitation at laboratories.

Senator GORE. When you say mostly analytical and visitation, do I understand that to mean that it is essentially an evaluation of what laboratories have accomplished?

Mr. SPORN. Both an evaluation and also analytical studies. Both nuclear studies and engineering studies to see how these ideas can be put together on paper. This is what you start with. You have an idea. You begin to sketch it out. You then begin to visualize what kind of form it might take. Then you try to see what kind of problems it would present and whether the thing would work at all; whether from a standpoint of reactor physics it has even a remote chance of operating, and what problems that would present.

You work away at that until you think you have gotten to a point where it either looks good enough to carry the next step or it does not look good enough and then you either start all over again on some new agle or you drop it entirely if it looks too discouraging. The stage that follows that generally is the prototype.

Chairman ANDERSON. I assumed when you said analytical that it meant reading reports and digesting those reports and doing educational work.

Mr. SPORN. I would think among the B. & W. staff they would go beyond that.

Chairman ANDERSON. How about your staff?

Mr. SPORN. It is being done jointly with B. & W. I don't think we have people capable of doing that.

Chairman ANDERSON. The folks that are working for your group are largely confining their work to reading reports and making an analysis of them?

Mr. SPORN. Yes. But also carrying on very intimate contacts and discussions with the other group, and cross exchange of ideas.

I come now to the fifth reactor, the liquid metal fuel concept. In this reactor the fissionable fuel material is carried in solution in liquid metal. Bismuth has been found to be the metal best suited for that purpose. Not only can it carry the fissioning fuel material, but it can

act in part as a moderator. For the full moderator effect required, additional graphite becomes necessary. Again, as in the case of the aqueous homogeneous reactor, thorium is proposed as the blanket to surround the core to end up with the fissionable isotope of uranium U–233.

The Brookhaven National Laboratory began work on such a liquid metal fuel reactor as early as 1947. I have been in intimate contact with the work that have been carried out on this reactor since 1953, when I became a member of the visiting reactor committee at Brookhaven. This concept of the homogeneous reactor plan appears to me to be perhaps the most daring and the most promising. But it is one—and this appears to me quite natural—that is least advanced, and, among the five I have mentioned, it is the least ready for exploration in a large-scale demonstration reactor.

Chairman ANDERSON. Would it be fair to say that all the work that is being done on this is being done at Brookhaven at the present time?

Mr. SPORN. Except for one piece of work that was done a year ago, Senator, by a team composed of some 16 or 17 industries in which our own company was represented, I think that is correct. That group carried out a feasibility study under the general direction of Babcock & Wilcox.

Chairman ANDERSON. They have some sort of contract now?

Mr. SPORN. That work preceded that. That feasibility evaluation was carried out and an elaborate study carried out by Babcock preceded this present contract the Commission announced it is going to negotiate with Babcock.

In 1954, our Brookhaven Visiting Committee recommended that a task force of scientists and engineers should make an economic and technical appraisal of this reactor and formulate a proposed course of action. The task force which was then set up included a number of people from my own company, American Gas & Electric Service Corp. The task force appraisal was completed in June of last year and, on the whole, was an enthusiastic one. The task force recommended the carrying on of additional research and development and the construction of a small experimental reactor.

As the committee knows, this recommendation has recently been acted upon. From a series of proposals for the design and construction of such a reactor, the Commission selected the proposal of Babcock & Wilcox, contingent upon an acceptable contract. I believe this is a significant step forward. On the other hand, it is my judgment that this reactor, which will have only 5 megawatts thermal rating and which will involve a cost of $10 million or more, is about as ambitious a step as can now be justified in the light of a great many more problems still remaining to be solved that can best be solved in the laboratory.

ChairmanANDERSON. This is the one that Florida Power & Light mentioned here the other day.

Mr. SPORN. I believe they have that idea.

Chairman ANDERSON. If it is as nebulous as this they have quite a bit of work before they get to it.

Mr. SPORN. In my judgment, Senator, this work that is proposed to be done at Brookhaven and will be done under the general direction of the Brookhaven staff—the people who conceived the idea and did

so much of the developmental and experimental work—is an absolute prelude to any demonstration project.

Chairman ANDERSON. Yes. Therefore, the Florida group will not get under way with their reactor for several years. It may be an indispensable step but you do not take the next step.

Mr. SPORN. I would not know how to make a suggestion for proceeding without that.

Thus, in my judgment, the LMFR reactor is not ready for a demonstration project. I am aware that one of the proposals under the AEC's second-round reactor-demonstration program contemplates development and construction of a reactor of this type to produce between 25,000 and 40,000 kilowatts of power, but I also believe the technical obstacles are such that some time will have to pass before this project can be realized.

In all the above, I have attempted to give the committee my opinion of the situation as regards the contribution the demonstration reactor projects can make toward the development of 5 potentially successful reactor types; 3 of these are in a very active stage of large-scale reactor development, 1 of them in England and 2 in the United States; the 2 others offer great advances in the technology of power generation by nuclear means but, by the same token, still have a great many problems that need first to be solved in the laboratory or in small pilot reactors.

I have not tried to test the assumptions of the Gore bill against all reactor types. I have thought it best not to try to cover reactor types with which I am not as thoroughly familiar as with the five I have discussed. At the same time, I want to make certain general observations.

Chairman ANDERSON. The high temperatures that are potentially in the gas-cooled reactors might change the economics a little.

Mr. SPORN. Yes, they certainly would.

Chairman ANDERSON. We had the testimony of a professor from the University of Wisconsin who indicated that if you changed the temperatures you would change the economics.

Mr. SPORN. You would improve the economics.

Chairman ANDERSON. We have not tried that. What I am trying to say is that some time we ought to try something of that nature.

Mr. SPORN. Senator, I agree with you. I am an absolute disciple and propounder of the economic generation of atomic power by raising the temperatures as fast and high as they can be raised safely and economically. The liquid metal fuel reactor is the most exciting from that standpoint. It offers the possibility of the highest temperatures that we have thought about so far in a practical nuclear power reactor.

At the same time, I believe there are some very difficult problems that we better solve on this smaller scale before we start in trying to put together large masses of material and machinery because in the long run I don't think we will save time by doing that.

Chairman ANDERSON. Apparently the Russians are going to build something of very good size. Would you assume from that that they are ahead of us in their metallurgy or technology?

Mr. SPORN. Senator, I don't know all I would like to know about what the Russians are doing. I am sure that is true of a lot of other people in this country. I think I know quite a few things they are

doing. I think I know it authentically. I was in Geneva and I saw what they showed us.

Chairman ANDERSON. They did not pretend that what they showed us at Geneva was all.

Mr. SPORN. No. And what they showed us was not particularly exciting. Maybe they didn't show us the exciting things.

Chairman ANDERSON. You will remember at Geneva that we were all playing it by ear and the Russians proceeded to declassify. You remember the incident where the Russian scientist was asked the point-blank question as to the type of fuel in a reactor and he looked around and could not answer. It was a question and answer period. He took the next question and started to answer it. So Beltson wrote something on a little piece of paper and sent it up to him. Now he said "To return to the question of a moment ago," and he proceeded to answer completely all the story about fuel. It had been declassified.

It is because of that experience that I do not believe we can judge the Russian program in reactors on what they revealed at Geneva. After they got home they began to talk frankly about it.

Mr. SPORN. Yes. But I have two things that may be helpful but not all the answers in connection with their atomic program. Both of those relate to conventional power in which field I have done a considerable amount of work personally.

At Geneva, I took occasion to talk to two top Russian technicians who were there on their conventional power technology. I talked to them for about an hour and a half. I had the help of a friend of mine who knew them. They apparently were quite frank. At least they were frank until they reached the point where they found out what they told us was not as good as what we were doing. Then they stopped being so frank. But my judgment, then, Senator, was that in the field of conventional power by thermal means, by burning coal and generating steam, they were a great deal behind us. Since then I have had the benefit of some of the late publications through a friend of mine who is the president of one of the large technical publishing houses in England, who was in Russia on a mission to arrange for the publication of Russian technical information in England, and he brought back a number of up-to-date technical papers written by the top technicians. These indicated that the Russians had advanced somewhat beyond the stage that I had thought they had reached in Geneva, but they still, I would think, are both in size of units and the kind of boilers, the knowledge of metallurgy which affects these designs, the efficiency of the units that they describe in great detail—and I have these papers in my office—they are a considerable period behind us; but I must say that I am surprised they are as far ahead as they are. They are nowhere near us in the ability to generate power by thermal electric means, using conventional fuels, economically. They are nowhere near us. That does not mean that I think we can rest content; that they are going to stay behind us.

I think they are catching up very fast.

I would think that the same limitations they have in their conventional technology would bother them in their atomic technology because essentially it takes the same kind of organizations—when it comes to building vessels and heating surfaces and boilers, et cetera, that is.

I would think that the Russians are not in advance of us at this moment, at least on the basis of information that bears the date of February 1956, but they may catch up to us.

That is no reason for complacency or to put our oars down and stop rowing. That is my best judgment.

Chairman ANDERSON. Did you feel that the evidence that they had material testing reactors that had been in operation as long as ours might indicate that they had some knowledge of metallurgy that was equivalent to ours?

Mr. SPORN. They might. They might have the knowledge and they might still have the difficulty of utilizing it. There was some evidence that they didn't have the technology of building large-scale pressure vessels.

Chairman ANDERSON. It is not a question of knowledge as it is that they are afraid of them. They have used expansions of other kinds rather than pressure vessels.

Mr. SPORN. I would feel a lot better, Senator, if I had the same contact with Russian technology that I am able to have with our technology here. I don't feel I can say I know all that is to be known about the Russian technology. I think I have a few hints. I think some of these markers or orientation points are reasonably accurate. But that is not saying that I have a full map that is completely charted and I know where they are going and where they might meet us and we would get into trouble .

I do believe there is every reason for not underestimating the Russians and I don't underestimate them.

To come back to my statement—First, I want to point out to the committee that it is one of the basic characteristics of our economic system that, in the advancement of any technology, those concepts and designs which show promise for advances in efficiency or economy tend to be selected quickly as they become ready for development. There is every reason to believe that this process is working and will continue to work in the atomic power field.

Second, it seems clear to me that the Nation's best interests will be served by giving every encouragement to private industry and other non-Federal interests to use their initiative and their resources to the fullest in the development of atomic power. The Atomic Energy Act of 1954, for the first time, provided such encouragement and opportunity. Legislation like the Gore bill would tend, in my opinion, to discourage such non-Federal initiative and progress.

Finally, I know the committee is well aware of the fact that we are undergoing in this country a critical shortage of engineering and scientific manpower. Your committee has taken this problem very seriously and has recently emphasized the urgency of it in the report of Congressman Price's Subcommittee on Research and Development, put out only a month or so ago. Any premature, large-scale construction of projects would mean a waste of a great deal of money. Even more important, however, under present conditions, it would mean a wasteful drain on engineering and other technical personnel which I know we cannot afford. Devoting the resources of the United States to a premature developmental program sets up a competition for technical personnel which the rest of the economy, not only in power but elsewhere, will find it very hard to meet. It seems to me, also, that such competition for tech-

nical personnel cannot help but slow down the great momentum being built up in reactor development by private industry and other non-Federal interests which the Atomic Energy Act of 1954 did so much to get started.

Considering the vastness of the problem, I believe what we have done to date, and particularly what we are on the way of doing, represents excellent progress. It should assure the continuance of great contributions by the United States to the solution of the atomic power problem and, I believe, continued leadership for our country in this field.

Chairman ANDERSON. I appreciate very much your testimony. I hope if you do review this other problem that we might have the benefit of your comments.

Mr. SPORN. I shall be glad to do so, sir.

Senator GORE. Mr. Sporn, I want to personally thank you for the fine contribution you have made to the committee's examination of this problem. Your statement is an astute, learned, well-written treatise on the subject.

I wonder if, as a result of your study, which is obvious from your statement, and your examination of the testimony of the last 2 days leaves us with the feeling that from the standpoint of the national interest—I say national interest—the present program is adequate?

Mr. SPORN. You know, Senator, I have not tried to answer that completely categorically in my testimony. I believe that on the basis of what I considered and what I know that the present program carried out and extended and given the proper momentum which it will pick up will do what we need to have done—give us the leadership, give us the reactor development. There is no question, it seems to me—and sitting here today and reading 1 or 2 items of testimony in the short period I had between the time I reached Washington and the time I came here this afternoon, makes it clear that there is a concern on the part of this committee, and perhaps it is a matter that should be of national concern, as to whether we are absolutely certain that everything that can possibly be done is being done. That is a difficult question to answer.

This point that Senator Anderson made, whether some kind of reactor that appeared promising at one time was not laid aside and left in a corner, so to speak, indicates the problem. One cannot say that is not so, that one is certain that has not happened unless one has looked into all the corners. I could not say that at least, and no other reasonable man who is concerned with the facts and the truth and who is not thoroughly familiar with every phase of the matter could say it. So it may be that something needs to be done to provide a mechanism to give that assurance to the Commission, to this committee, and to the country at large.

I believe there may be such a mechanism. As perhaps the Senator knows, I was chairman of a committee set up by the Atomic Energy Commission in 1950, called the ad hoc committee on cooperation between the electric power industry—not the private power industry—and the Commission. It was a very small committee. It included Walton Seymour, who was at that time the head of the Power Division

of the Department of Interior and Edward Morehouse, who had a solid background in economic analysis and was for many years on the staff of the Wisconsin Public Service Commission and had in later years as now been a member and officer of General Public Utilities, which is a private power company operating in the eastern part of the United States. We made a very thorough review in 1950 and 1951 of the power program at that time and submitted a report to the Atomic Energy Commission, to Mr. Dean, who was then chairman in March, 1951, recommending what appeared to us to be very necessary at that time, an Industry Advisory Committee on Atomic Power—a permanent Industry Advisory Committee.

In that recommendation, we suggested a committee of top-level technicians, of possibly 12 to 15 people with a solid engineering and power background but not exclusively so, and a committee representative of the power industry, public and private.

That committee was never set up and I am not sure we would make that recommendation today.

This thought that I offer you here, since it is more or less extemporaneous and I have not had a chance to discuss it with my colleagues, particularly the nuclear power group, the other directors, is my own. It seems to me that the problem today in this reactor field is not political unless it is international political. There are international political connotations. The problem is technological and technological-economic.

You start out with the assumption which I think is pretty well the established policy of the country—I think it has been enunciated clearly enough—that we want to maintain leadership, which we think we have and I believe we have today, in the atomic power field. That is to the interest of this country. If you start out with this you follow into this kind of thinking; that it is important that we develop every reactor type that gives promise and we need to look not only at our own picture but also at the international picture.

I believe that one way of assuring it would be through some kind of high level technical evaluation group, reporting to the Commission. I would think it would have to be a group of something between 10 and 15 people in order to be sufficiently representative. I would think it would be drawn heavily from the technicians and economists of the power industry. But I would also think that it ought to have in it a number of scientists. We have some very great ones in this field. One of them is sitting in this room here today. It ought to have representatives from the important manufacturers who are really doing a job and spending a great deal of these resources.

I believe that such a group set up by the Commission and given a directive to keep in intimate contact with the reactor program all over the country as it is going on in the laboratories, both national and private, with everything else that is going on in reactor development, reporting perhaps periodically, perhaps twice a year, but meeting more aften than that, if it were properly chosen, would lend a great deal of help and assurance to the Commission that nothing is being neglected. If it did that, its work would be available to this committee and the country.

I think that is one mechanism. I suggest it because it seems to me it is a logical development of an idea that we proposed in this 1951 report to which we gave a great deal of thought.

We spent many, many days arguing and examining that concept before we put it down on paper and presented it to the Commission.

That is the one thing, it seems to me, the country wants—assurance that we are not neglecting any line of effort that the country needs to have pursued.

Senator GORE. That is the purpose of the bill we are discussing today.

I would like to say that as a Senator from Tennessee I sometimes find myself torn between a national point of view, one the one hand, and a regional point of view, or sometimes an ever narrower point of view, a State point of view. I suppose every Senator faces that.

Mr. SPORN. That is true of a lot of other people besides Senators.

Senator GORE. I want to compliment you for coming here and taking what I consider to be a broad responsible point of view. I have found your testimony extremely interesting.

It appears to me that you have attempted to divorce yourself insofar as one practically can from a personal interest and industry interest. You have given us some good testimony.

I think the suggestion you have made is very good. However, the Commission itself is charged with that specific responsibility which you suggest that a committee might serve.

Mr. SPORN. I would prefer to call it, Senator, really a technical evaluation group.

Senator GORE. I think you have a valuable suggestion. I do not wish to press you on the question of the adequacy of the present program, but I would hope, Mr. Chairman, that at the time Mr. Sporn supplements his remarks to reply to Senator Jackson that he might also make whatever addendum to his remarks he may desire with respect to my question.

Mr. SPORN. Thank you, Senator.

Chairman ANDERSON. Mr. Sporn, I have been sort of turned around in my mind here as to how much I could ask you and walk pretty closely to the limits of classified information and yet not go beyond what I should ask you properly.

I think when you say we have leadership, I am going to ask the question anyhow. I am dealing with the technology of the Russians as to how much they are behind us or ahead of us. I am not going to go into the new cyclotron again, because our own scientist, Dr. Libby, admitted that they are ahead of us. He has to admit it. There is nothing else he can do about it. I am not going to dwell on the fact that they will have a nuclear-propelled surface vessel in the water maybe this year and certainly next year in their icebreaker and we won't have anything for a long time. Leave those things out.

You were at Geneva. You know that at Geneva there was a full, frank description by the Russians of their 5,000-kilowatt station. I assume you are familiar with what they said about it?

Mr. SPORN. I am familiar with it.

Chairman ANDERSON. That station has been running since 1954. This is now the year 1956. Will you compare the heat transfer performance of that station with the best station we have in the United States as (a), and then will you deal with the heat transfer performance of that station that has been running since 1954 with the anticipated performance of the Dresden station and say whether or not it is superior?

Mr. SPORN. I will be glad to, Senator, but these are very rough figures. The Russian 5-megawatt reactor is considerably below the expected thermal performance of Dresden thermal performance is measured by the amount of heat you put into the heat transfer surface of your medium—water in both cases—versus the amount of energy you get out in the form of electrical energy at the generator; the ratio of the output to the input being the thermal efficiency. My judgment is that the Russian job of the 5-megawatt reactor certainly would be at least 25 percent poorer thermally than what we are going to get at Dresden. Dresden is considerably poorer than the best we are doing in conventional generation. Dresden is a considerable advance over Shippingport or over the Russian job, I think.

Chairman ANDERSON. In the Russian job—I am not a technician in any way so I have to repeat things I have picked up—has local boiling. Would you not regard that as rather high-class technical work?

Mr. SPORN. I think it is.

Chairman ANDERSON. Have we anything like it?

Mr. SPORN. Boiling?

Chairman ANDERSON. Local boiling.

Mr. SPORN. I am not sure I know how to answer that, Senator.

Chairman ANDERSON. May I ask you to comment, Dr. Zinn, a little bit? I have only this feeling, that a Russian station delivering 5,000 kilowatts have been doing reasonably good work and we have stations that can do reasonably good work. But I have the feeling it is dangerous to believe that everything we have done is superior to what they have done and that we have this enormous leadership.

Mr. SPORN. Senator, may I say that I am sure you and I agree that neither one of us thinks that we have enormous leadership. It is my judgment that we have today leadership in the technology of generating power by nuclear means as against the Russians or the British, for that matter.

Chairman ANDERSON. I was a member of the National Security Resources Board, I think, for a short time, but in any event in one of those Boards I attended a meeting at which an expert on the construction of jet aircraft explained that we had tried to get a new type of graining in our motors but American engineers found it was impossible to get that graining. Then when we got our hands on the first Russian jet we found it. From that day on I have not been willing to say that somebody else can't accomplish something.

Mr. SPORN. I thoroughly agree with you.

Chairman ANDERSON. I would like to have Dr. Zinn comment on this question of heat transfer performance or anything else he cares to.

Dr. ZINN. I would like to first say that I would agree with Dr. Sporn. My estimation of the comparable status was and is that we have technical achievements that are greater and broader than the Russians.

I did observe that on a particular point, such as heat transfer in their station, where they have local boiling heat transfer, and I think you know what that means, they have heat transfer rates that run around 400,000 B. t. u.'s per square foot per hour, which are really

very high and which I suspect is what you are hoping to achieve in your Dresden station.

Mr. SPORN. Yes.

Dr. ZINN. That is the rating they gave in their paper for their reactor.

Furthermore, if you will notice Kurchatov's paper, in which he lists the various reactors, where they talk about their gravity motivated water cooled, they don't say "water cooled." They sad "water and steam." Did you notice that?

Mr. SPORN. Yes.

Dr. ZINN. That means local boiling. This is high-class heat transfer performance as I admit and I am sure you admit. It does mean a good high level of technology on a very vital point.

Mr. SPORN. I would like to make this observation again. I believe on the scientific end the Russian performance is altogether too close to ours. Maybe it is actually superior to ours, although some of my scientist friends tell me that is not quite so. But they are very close and we are the only ones that come close to them. Whether we are close to them or they to us I just do not know. That is on the scientific end.

On the engineering end, Senator, it is my judgment that the situation is just about as I gave it but that we would be guilty of the grossest kind of rashness if we assumed that because we are ahead of them at this particular moment that that gives us assurance of staying ahead even if we falter for any period of time. I do not think we can afford to falter. I think that is the concern of your committee, Mr. Chairman.

Chairman ANDERSON. I am only trying to say to you that I have said publicly, I have said privately, I have gone into areas where I was about to deliver a talk and had a press conference, which was a little ridiculous because I am certainly no expert on atomic energy, that I thought America was ahead of the world. I want to cling to that and hope it is true and believe it is true. But I do believe that there are enough things going on in other parts of the world so that it would not be unwise to experiment with every promising type of reactor even though it does not meet every requirement that we now see.

As far as American industry is concerned, I listened to the statement this morning about how awful the Gore bill would be to American industry, it would seem to me that the experimentation with these additional types would give smaller companies, and perhaps those that are not yet in the program, an opportunity to try things out and to interest people. The very fact that they were doing that would again be reflected back in the numbers of high-school children that are going into scientific pursuits. I think we are in a very serious race.

Mr. SPORN. I do believe, Senator, something like this: this becomes a complex, economic problem, call it a technical-scientific-economic problem. You need the scientist in back of the technician and you need the economist.

Since we are talking about generating energy commercially in order to improve the economic well-being of the country, you need economists. Every time you spend more than you get out, the country does not get richer. That is my belief. I don't care what system of

political economics you have, that is true. Therefore, you need these three groups working closely together. I would think that a technical group of that kind, composed of very high grade people—and we have them in this country, Senator, and you and I both believe that—would certainly be an excellent sort of agency to throw a problem like that to. You would say, "Look, this bothers us, but you really look into everything. If there is a question about what the British are doing, find out, even if you have to go abroad. It doesn't take very long these days. You tell us."

Chairman ANDERSON. That has been the purpose of these hearings. The Atomic Energy Commission is fully satisfied with its present program. If these reactors are finished by 1960 or 1961 or 1962, the Atomic Energy Commission will be satisfied.

I would like to believe that we do not just stop with these types but we do try some other types. I recognize that it would be uneconomic. Maybe we want to go to what I termed this morning the Shippingport approach, where the Government spends the money for building a reactor and an adjacent utility takes the steam and turns it into electricity and proceeds to distribute it through its lines at some agreed upon price as we have done in the Shippingport operation. But until we have tried a gas-cooled type with the modifications that have been suggested to give us a range of higher temperatures, until we have tried to find out whether the Savannah River reactor adopted to power instead of plutonium might not be a very successful operation, until we have tried the Hanford type, I do not believe we have covered the whole field.

I would like to place a few more bets, that is all.

Mr. SPORN. I would like to say one more word on this, Senator. I believe the program that the Atomic Energy Commission has under way is excellent. I think it is doing a marvelous job. On this question as to whether we are really exploring every concept, whether there is not one or another, maybe 2 or 3, that ought to be taken a good look at and, if they look promising, whether they should not be pushed along farther, whether private industry cannot be interested in doing it and, if they are necessary from a national standpoint and nobody will do them in the power industry, whether the Government ought not to do it, that I think both the Commission and this committee could get effective help on from such a detailed knowledgeable evaluation from a group of the kind I have in mind. That is what I believe.

Chairman ANDERSON. Thank you very much.

Senator GORE. You got up to three. Would you go up to six?

Chairman ANDERSON. Mr. Webster?

We thank you very much. You come at the end of a long week and we have a little more next week. I appreciate your patience this afternoon and your willingness to come down to try to help us.

STATEMENT OF WILLIAM WEBSTER, PRESIDENT, YANKEE ATOMIC ELECTRIC CO., BOSTON, MASS.

Mr. WEBSTER. Thank you, sir.

My name is William Webster, of Boston, Mass. I am president of Yankee Atomic Electric Co., and my testimony today relates primarily to the work of that company. I am also executive vice president of New England Electric System, one of the group of New England

utilities interested in Yankee as a stockholder and purchaser of power from Yankee's proposed nuclear project.

I am grateful for this opportunity to appear again before the Joint Committee on a matter of great public importance. Last week's hearings were devoted to the somewhat technical problems of insurance. To the general public those hearings emphasized, probably unduly, the possible risks of a reactor incident. The public quite naturally looks to the present hearings for an answer to these next questions: Is sufficient progress being made in the technology and development of power reactors to justify any possible risks involved and the great sums expended? Is our civilian reactor program keeping pace with developments abroad?

The testimony you are hearing this week seems to me to provide highly reassuring answers to these questions.

What I can add comes under two main headings. First, I should like to review in some detail the Yankee program, its objectives where we stand today, and our hopes for the future. Then, more broadly, I should like to indicate very briefly the reasons for my belief that the civilian reactor program, which is moving forward with increased momentum, is the best means of achieving the objective of economically competitive power.

Turning first to Yankee and its program, let me review hurriedly the essential vital statistics. Yankee is a newly formed corporation whose stock is owned by a dozen of the major New England utilities. Yankee was formed for the purpose of undertaking the construction and operation of a demonstration power reacter. Its equity capital will be provided by its utility stockholders who will also purchase the entire electrical output of its plant, which will thus be integrated into the New England power grid. The plant will use a pressurized water type reactor and will have an electrical capacity of approximately 134,000 kilowatts. The output of the plant will be approximately 4 percent of last year's generation in the entire New England region. As I indicated last week, if the insurance problem is solved, we feel that we can work out the remaining problems without new legislation. We expect to commence major construction next spring and to have the plant on the line in 1960.

To put the Yankee project into perspective as a part of the civilian reactor program, I should like to sketch in briefly some of the background. First, as has often been pointed out, New England must import its requirements of coal and oil from other parts of the country, and these added costs are necessarily reflected in higher power costs. As a result, New England is one of the areas where atomic power will first become competitive in cost with power generated in conventional plants.

On the other hand, our New England untilities are relatively small and with more limited resources than some of the larger companies of our industry. We have felt from the outset that we have a responsibility to play a part in the development of atomic power, and that we could move forward at an earlier date by means of a group approach than any one of us could do individually.

With this background we early canvassed the whole range of reactor types. Our objectives were these: First, to select a type of plant for prompt installation. Second, to select a plant that promises reasonable reliability in operation. Third, to choose one that, even though

not competitive at the outset, would be sufficiently flexible to take advantage of anticipated improvements with the goal of truly competitive power not hopelessly out of reach. As a result of our survey we selected the pressurized water type of reactor as most nearly satisfying our requirements. The plant we propose to build will take advantage of the very considerable body of reactor technology in this field, but will use a new type of core which promises improved economic performance and may hopefully bring us within striking distance of competitive power.

We are under no illusions that this plant will set the pattern for the long range development of power reactors; it will have amply served its purpose if it marks an intermediate milestone along the route.

Chairman ANDERSON. Just above, you said: "As a result of our survey we selected the pressurized water type of reactor as most nearly satisfying our requirements." Did you have a second choice? Did you find some other things that were interesting?

Mr. WEBSTER. We started with a whole broad horizon, sir, and came really to our final guess on two bets.

If the homogeneous reactor seemed close enough so we could get started with it and bring power to New England by 1960 or 1961, we would go that route.

It appeared to us and apparently borne out by the judgment of other people that this was not sufficiently far ahead. It was important that work be done on a prototype homogeneous reactor before we could get one of a size suitable for integrating the power into our system and we could count on as being reliable for full scale operation, we dropped back to the pressurized water type not as the best reactor but as the type that fitted best our goal of being prompt with it and of getting an opportunity to have our engineers and operator and dispatchers learn how use one of these things.

We felt that we were probably going to be one of the first places where this would be competitive.

Chairman ANDERSON. I think so, too.

Mr. WEBSTER. Getting going fast was more important than putting in what would eventually be the type of the future.

Chairman ANDERSON. Thank you.

Mr. WEBSTER. Whatever the ultimate future of the pressurized water reactor may be, it seems destined to provide a substantial portion of the first increment of atomic power, and our experience with this plant may well point to refinements will be incorporated in succeeding reactors of this type. Our own New England utilities, like others throughout the country, are already planning 5 and 10 years ahead for the additional capacity which will be needed to carry out growing powerload. Atomic power has an important place in these plans, and each of us is looking to the experience of the first generation of reactors to determine our eventual selection.

Chairman ANDERSON. Are you at all disturbed that so many of these reactors round the country are apparently going to be the pressurized water type? Are we getting enough diversity of experimentation in this?

Mr. WEBSTER. I would like to answer that from two angles. From Yankee's angle I am delighted because it means that if one of the others show up with a fuel element that is superior to the one we are

working on, the pressured water type in the particular plant that we have is flexible enough for us to take advantage of that and to have lower power costs for our consumers. We will be just that much closer to being competitive. Assuming for the moment that you asked from the national point of view and from the angle: are we getting far enough ahead?, I don't think the fact that there are several pressurized water reactors is the answer. I think we should consider, are we having prototype work done on the whole broad field so that no bet is missed.

I listened carefully to Mr Sporn's testimony and he said it a good deal better than I could probably just what I feel.

Chairman ANDERSON. Thank you, sir.

Mr. WEBSTER. Yankee's program has now passed the preliminary stage and is moving forward at an accelerated pace in order that we may complete the necessary design and engineering work in time to commence construction in the spring.

Our program has been accepted by the Atomic Energy Commission as one of the projects to be included in the first round of the power demonstration reactor program, and we are now negotiating the detailed terms of a contract with the Commission. Our license applications are in preparation and will be filed in the near future, so as to permit the issuance of the necessary construction permit well in advance of actual construction. A site in western Massachusetts has already been acquired and preliminary engineering work is in progress there. We have selected Westinghouse Electric Corp. and Stone & Webster Engineering Corp. as our contractors. Both firms have assigned personnel to the job and are working out general designs preparatory to the elaboration of final detail plans and specifications. Westinghouse, for example, has worked out an improved core design, with preliminary evaluation expected within the next few weeks. The final core design will, of course, reflect the results of a continuing research and development program, the plans for which have already been formulated.

Preliminary approvals by the Massachusetts Department of Public Utilities and the Securities and Exchange Commission give us confidence that there will be no major regulatory problems that cannot be solved as our program progresses. We expect to be able to finance the project on a conventional utility basis and foresee no tax problems that present major obstacles. We are confident that some acceptable solution of the insurance problem can and will be found.

In summary, then, as we move into the next phase of our program, we foresee no insuperable obstacles that might force a major change in our schedule. We are going ahead in the confidence that construction will be commenced next spring and that the completed plant will be in operation in 1960. We expect, too, that by then others will be drawing on our experience in planning future nuclear power installations of their own.

Turning next to the broader question of whether our civilian reactor program is making satisfactory progress, I am aware that public concern arises primarily from announcements that Britain and Russia will have nuclear generating plants on the line before any of the civilian reactors in this country will be completed. There has been relatively little information available to the general public on the

relative merits of the reactors now underway, both in this country and abroad, and the differing objectives which they serve.

Britain has an acute fuel shortage and wants atomic power at the earliest possible moment, with cost a matter of concern, but of secondary importance. Russia is power short, and must have additional generating capacity to back its ambitious program for industrial expansion. The reactor types now being developed in both countries are dual-purpose reactors designed to produce additional fissionable material as well as to serve the basic power need. While relatively little information is available as to the cost of the power output of these reactors, it is plain that any figure for power alone will vary up or down depending upon what arbitrary value is assigned to the output of fissionable material.

In the United States we have no fuel shortage and no power shortage. We are not, therefore, interested in power without regard to cost, but in power at costs competitive with conventional fuel-fired plants. There is very general agreement, therefore, that our national program should omit a wasteful intermediate step of building uneconomic reactors, and should point directly toward the development of reactor types which give real promise of developing economically competitive power without reliance on a high value assigned to the fissionable material produced.

Judged on this standard, our civilian power reactor program is well advanced and gathering increasing momentum. The first generation of civilian power reactors will be coming on the line in 1960 and at an increasing pace thereafter. All important types of advanced reactors will be represented in this first group, and additional projects will be undertaken throughout the country as work on these pioneer projects progresses, and even before they are completed and in operation.

The immediate problem under consideration in these hearings is whether a crash program underwritten by the Federal Government would accelerate the present pace of development. If our objective is to achieve the greatest number of kilowatts of atomic generating capacity at the earliest possible moment without regard to cost, this can, of course, be achieved by such a program. However, it would delay work on advanced reactor types, and would thus involve a waste of manpower and investment that we can ill afford.

If, on the other hand, our objective is to achieve economically competitive power at the earliest possible moment, such a program will almost certainly stifle the broad participation now developing in the civilian reactor program and could well result in sacrificing the progress thus far made and the momentum that is now developing.

A crash Government program such as this raises many collateral problems of policy not wholly germane to the basic issue here. Leaving these problems aside, I should like to point out what I believe to be the fundamental reasons why our overall national interest would not be served by such a program.

First, we must remember that any program, Government or civilian, can proceed only as fast as advances are made in basic reactor technology. This is not a case of putting more dollars into a program to step up the production of hardware, but a case of accelerating the growth of new ideas and their development into practical and useable form. It is my belief that this objective can best be achieved by en-

couraging competitive efforts on a broad front, rather than by channeling our effort into a major governmental program operating under a single direction.

Second, we are all well aware of the fact that our reservoir of inventive and technically trained men is critically limited. In this essential respect we may not have the resources to support both a Government program and a parallel civilian program. Any crash Government program must inevitably absorb the primary efforts of the men who are now devoting their attention to the civilian reactor program. To the extent that their efforts are reoriented to serve the aims of a new program, their present efforts will be abandoned, or at best postponed, until the priority demands of the Government program have been satisfied. In addition, by assigning top priority to the Government reactor program other vital areas of development may be seriously neglected. As an example, I would cite the problem of chemical reprocessing which is now under intense study, both by the Commission and industry. This important problem in the development of economically competitive power would quite naturally be assigned a lower priority in a crash program where costs are not a limiting factor.

Finally, I feel that there is important merit in having our major effort in developing economically competitive power undertaken by industry, where cost differentials are the inescapable standard in determining success or failure in a competitive market. This alone guarantees that every promising lead will be explored, as has already proved to be the case. We can be certain that the competitive spur toward lower costs will be keener as our experience with the pioneering projects brings the goal of truly competitive power more nearly within range.

Summarizing, I believe there is little disagreement that our fundamental objective is economically competitive power, rather than kilowatts at any price. It is my belief that the civilian reactor program is now well underway and gathering momentum. A crash Government program would substantially supersede the civilian reactor program by diverting our limited supply of technically capable men from the efforts already underway, and by preempting the limited opportunities for absorbing the unreliable power output of an experimental plant in existing systems where it can be backed by an adequate supply of firm generating capacity. I feel certain that we can best achieve our objective of developing economically competitive power by continuing to support the civilian reactor program, taking advantage of the drive toward lower costs which exists in a competitive market. As I see it, any alternative course involves all the well-known hazards of swapping horses in the middle of the stream.

Chairman ANDERSON. Are there any equipment manufacturers who might have ideas and who, if we started one of these other reactor types, might be able to make a contribution to this program without disturbing the manpower that now exists?

Mr. WEBSTER. I feel there are some that could do it without seriously disturbing it, if we distinguish from working on prototypes and the early stages of the work rather than too big a full-scale effort.

Chairman ANDERSON. Let us just take Savannah River. The Du Pont people built that. As I understand it, in this new reactor

program no attempt is being madet to utilize the knowledge and technical skill and trained personnel that Du Pont developed in the Savannah River project. Suppose we should say to Du Pont, "Having built this one, having gone this far, suppose you take the Savannah River and try to adapt it not to plutonium but to power." I do not think that would disturb the outstanding manpower situation in this country.

Mr. WEBSTER. I am not aware that Du Pont has been trying to develop a civilian reactor group, sir.

Chairman ANDERSON. I am not, either. But they could not go down there and spend a billion dollars of this country's money and not have a little rub off on them. They built reactors.

Mr. WEBSTER. They built good reactors.

Chairman ANDERSON. I thought so.

Mr. WEBSTER. Certainly those men are not doing nothing now. I am not in a position to say.

Chairman ANDERSON. They are making paint and varnish and chemical fertilizers.

Mr. WEBSTER. I am not in a position to say what would be handicapped.

Chairman ANDERSON. How did Westinghouse get into the program? If you just assume that only the people that can do these things are the people that have the staff, General Electric went to Hanford but we found places for other people to fit into the program. Where did Westinghouse get in?

Mr. WEBSTER. It is like an elevator; whenever anybody else gets in everybody else crowds over.

Chairman ANDERSON. I would be hopeful there might be a sufficient reserve in this country so that if the program is spread out, and it would be, that these new organizations might find ways of making contributions along with the others, and thereby keep us where I think we ought to be and I know where you feel we ought to be and where you feel we are. Nevertheless, I would like to try some of these other things.

Dr. Zinn reminds me that it is the equipment manufacturers who are providing the manpower and not the utility companies.

Mr. WEBSTER. By and large that is correct. We have felt that it would be a mistake for us to assemble an all-star team for one shot. We plan to use consultants and have a few nuclear men in our group. We will lean heavily on our supplier.

Chairman ANDERSON. Thank you very much for being here. The hearings will resume on Monday, in the old Supreme Court room, P–63 of the Capitol, at 10 a. m.

(Whereupon, at 5 p. m., Friday, May 25, 1956, the hearing was recessed until 10 a. m., Monday, May 28, 1956.)

ACCELERATING CIVILIAN REACTOR PROGRAM

MONDAY, MAY 28, 1956

CONGRESS OF THE UNITED STATES,
JOINT COMMITTE ON ATOMIC ENERGY,
Washington, D. C.

The Joint Committee met at 10:10 a. m., pursuant to recess, in room P–68 of the Capitol, Senator Clinton P. Anderson (chairman of the Joint Committee) presiding:

Present: Senators Anderson, Pastore, Jackson, and Bricker, and Representatives Price and Cole.

Present also: James T. Ramey, executive director, George Norris, Jr., George E. Brown, Jr., Wayne P. Brobeck, and David R. Toll, of the Joint Committee staff.

Chairman ANDERSON. The Joint Committee will be in order.

Our first witness this morning is Robert McKinney, who was kind enough to serve as chairman of the panel on the Impact of the Atom on our Economy. We will be very happy to have you testify, and I am glad you have along with you Herbert Miller, who did very distinguished service in connection with the work of that panel.

I am sure we are all glad to welcome him back to any hearing conducted by the committee.

Before you start in, Mr. McKinney, I note in one paper three little items. One is entitled "Heavy Soviet Aid Seen in Red China."

I should feel relieved if United States aid to India were one-fifth as large as Russia's aid to China. Nothing can stop China in a generation from being one of the leading countries of the world, a British economist said.

A great deal of aid and assistance is being given by Russia there. I could mention the story which says "Russia Spurs Africa Drive of Diplomacy and Trade," and tells what they were doing in Russia. They have some nice terms. They have an Institute for the Study of Contemporary Capitalism in the Moscow Academy of Science.

I have just been handed a clipping saying "Russia will help Communist East Germany build and operate its first atomic power station. An East German Government announcement says the plant will begin operation before 1960." The final one is that "Peiping flaunts its economic aid," a story out of Hong Kong telling what is being done in that part of the world. There is another story that Pakistan rejects East Zone Red aid and that the people are starving in the villages, and so forth. Atomic energy could give them some help on agriculture. We don't need it so much here at home to produce more surplus crops but there are areas in which that is important.

I am sorry to bring that in before you started in, Mr. McKinney, but we have been greatly interested here in the possibility that some

of our technology may be of real aid to these countries. I know that you have been very much interested in that subject, as was the panel.

Mr. McKinney.

STATEMENT OF ROBERT M. McKINNEY, EDITOR AND PUBLISHER OF THE SANTA FE NEW MEXICAN

Mr. McKinney. Mr. Chairman and gentlemen, my name is Robert McKinney. I am the editor and publisher of the Santa Fe New Mexican. I served as Assistant Secretary of the Interior in a previous administration and more recently had the pleasure and honor of serving for this committee on the citizens panel to report to this committee on the Impact of the Peaceful Uses of Atomic Energy.

I am grateful for the opportunity to appear before this distinguished committee to develop further some ideas I have been exploring in a preliminary way with some of the members of the committee and to speak specifically on the need for expanding our atomic power reactor demonstration program.

As this is my first appearance before this committee since presentation to you of the report of the Panel on the Impact of the Peaceful Uses of Atomic Energy, may I again express the gratitude of all nine panel members for the rewarding opportunity afforded us by the Joint Committee to study this new subject and to acquire education so broad, so intense, as to give us all new outlooks.

There are some who feel that the domestic atomic power demonstration program is lagging and that a crash program is required lest the United States lose the atomic power race. It is in that connection, as I understand it, that the present hearings before the Joint Committee are being held to determine whether, in effect, the present domestic demonstration program should be doubled by directing the Atomic Energy Commission to build, with public funds, six more nuclear power demonstration plants, in different geographical sections of the United States, over and above and in addition to the reactor development program now being carried out by the Commission.

It appears to me that consideration of the proposal contained in Senate bill 2725 calls for three different determinations:

1. Whether the present demonstration program is in fact lagging, and, if so, in what respect lagging.

2. Whether additional demonstration plants would serve any useful purpose; if so, what purpose; and, if built, where they should be built.

3. Whether enlargement of the demonstration program should be on a crash basis; and, if so, what are our capabilities in technical manpower and facilities for a crash program.

In other words, the Nation is looking to the statesmen on this committee to establish the real facts, to measure the real needs, and determine the best means whereby the peaceful uses of atomic energy in general, and atomic power in particular, can be brought most efficiently and beneficially to the United States and the world.

If, as one newspaper editor, I am any judge of public opinion, the Nation is confident that this distinguished committee will not cause the building of a lot of atomic powerplants, just for us to look at, brag about, and subsidize. The Nation is confident that this committee

will keep the scientific, engineering, and technical problem of harnessing the atom separate from unrelated political controversies.

Not long ago I had the privilege of hearing the President's most recent foreign policy address—the one last month to the American Society of Newspaper Editors. In this address the President proposed the establishment of a nonpartisan citizens' commission to review our international policies and to recommend additional ways and means of meeting the Soviet threat. The Foreign Affairs Committee of the Senate and the Foreign Relations Committee of the House of Representatives have of course long been concerned with all the many facets of this grave subject. You on the Joint Committee have been equally concerned, as I so well know from having traveled with you to the Geneva Conference last August.

In the address which I mentioned, the President made specific point of the fact that any person who sees or believes he sees some of the basic factors in the problems facing the Nation, and who has some little ability or opportunity to explain them to others, has the responsibility to do so.

The President's statement started me thinking about how the studies of the peaceful uses of atomic energy by our citizens' panel for the Joint Committee could be brought to bear to help provide additional ways and means to meet the new aspects of the Soviet threat. This threat, of course, does not arise from any shortage of electric power in the United States, nor from the possibility that atomic electric power may soon be generated in quantity in Russia.

In our international chapter, the panel reported to you gentlemen that:

> The humanitarian applications of atomic energy can make significant contributions to the health and prosperity of peoples throughout the world. * * *
>
> Atomic power may be the most tangible symbol of America's will to peace through the peaceful atom. Our domestic needs cannot be our only motivation. Otherwise, we leave without effective rebuttal the argument that America is so rich, so prosperous, that a revolutionary new energy resource can emerge without any urgent need on our part to put it to man's use. This must seem a strange position indeed to peoples possessing neither conventional fuels nor technical capabilities to put the atom to work.
>
> If we fail to act to bring atomic power to the free world, other countries will do so ahead of us, or progress will proceed at a slower pace.
>
> Peaceful uses of atomic energy will inevitably be developed throughout the world. The United States must lead.

Having thus reported, the panel was dissolved and no longer exists. In appearing here today, I am of course speaking only for myself and only as a private citizen.

In recent weeks, I have been trying to organize some ideas—developed from the panel's findings and extending further on my own some of the panel's conclusions—as to how the peaceful uses of atomic energy can be brought to bear on the most fundamentally decisive problems now facing the United States.

May I again emphasize, Mr. Chairman, that this problem is not a present domestic shortage of energy resources or electric power.

THE PROBLEM

I believe the real problem is: How can we put a stop to deterioration of America's position of leadership abroad? And how can be restore the faith that the rest of the world only recently placed in the

United States as a symbol, not only of material, but also of moral progress?

I believe that this deterioration can be stopped, this faith restored through the peaceful uses of atomic energy. I firmly believe this for one fundamental reason. The reason is that the peaceful uses of atomic energy have completely captured the imaginations of the peoples of the world.

And this fact leads to two basic propositions:

The first proposition is this: That the peaceful development of atomic energy gives the United States an opportunity such as we never had before to win respect, good will, and friendship throughout the world.

The second proposition is: That we must grasp this opportunity now—and by now I mean immediately—for we may never have it again.

These are pretty broad statements. But to me they are the only conclusions which can logically flow from the demonstrable facts.

For the first of these "demonstrable facts," let us look at where the United States stands today in relation to the uncommitted nations of the world.

In Ceylon an election is held and it is assumed that the government earnestly friendly to the United States will be reelected. But this government is soundly beaten by an opposition which says that, because it is anticolonial, it must therefore be anti-American. Coming elections in Iceland, Nepal, and elsewhere seem to be shaping up the same way.

In the Middle East we painfully build a structure of military alliances shored up with conventional economic aid, along the so-called northern tier, feeling sure that the Arab region to the south is safe. Suddenly we find the Arab nations turning against us, and the balance of power in the area tipping toward Russia.

America is learning the hard way that the expensively and painfully won good will of governments lasts no longer than the governments themselves last. Only rarely does it carry over to the people.

This is true not only of former colonial countries now going through the growth pains of national, political, and economic independence.

It is true also of many established, industrialized nations.

It is true of countries with which he have formed defensive alliances and to which we have given billions in military aid. It is true of nations to which we have given billions in economic aid. It is a fact which has become increasingly clear in just the last few months since the Russians made a scapegoat instead of a saint out of Stalin, turned the guillotine into a maypole, and put on the market their new tactic of Soviet service with the Soviet smile.

A NEW ELEMENT

So the first demonstrable fact to which I would like to call your attention is this: We need some other element—something besides defense alliances and military aid, something besides conventional technical and economic assistance. We need it to convince the peoples of the world, as well as their leaders, of what we have been trying for the last decade, but so far have failed to convince them of—that the United States is truly their friend and deserves their respect and trust.

To me, the second demonstrable fact is that the peaceful uses of atomic energy can provide the new element, the new ways and means we need.

As the panel's findings unfolded over the period of nearly a year, I came to recognize a tremendously important facet of this complex subject of atomic energy. This facet is that it is exactly those countries which have the most need for peaceful atomic uses now that have the least chance of getting them by themselves any time soon.

As you members of the Joint Committee so well know, atomic techniques can be expected eventually to make farming productive in many areas where today it is either impossible or, at best, marginal. In the United States farm surpluses are serious problems. Atomic techniques which would add to these surpluses are certainly not essential. But in many other countries, in North Africa, Egypt, India and the Far East—hunger, the stomach instead of the head—is the only influence which motivates hundreds of millions of people.

A NEW HUNGER

There is another, a new kind of hunger—the hunger of nations for fuel and electric power, the hunger which comes from not having adequate energy resources. We in America have never felt that hunger. Even without atomic energy, we in the United States will not run out of coal or oil in our lifetimes. Parenthetically, I might note here that one of the useful byproducts of our panel report was to help put our reserves of conventional fuels in their true light. A study group, headed by Wallace E. Pratt, and working from new data provided in confidence by 28 leading oil companies put together an estimate of domestic and world crude petroleum reserves which has had revolutionary impact not only on thinking in the oil industry, but in the chanceries of the great powers.

The previous best estimate of proved domestic crude petroleum reserves was 29 billion barrels; our panel report increased the figure to 35 billion. As for proved reserves in the Middle East, the previous best estimates was 97 billion barrels. Our panel report—and I believe it realistic and hardheaded—put proved Middle East reserves at 230 billion barrels.

As for coal, we found that domestic reserves, recoverable at or near present costs, equated out to around 500 years' supply at present rates of consumption.

Chairman ANDERSON. That domestic figure on coal is for the United States?

Mr. MCKINNEY. Yes, sir.

Other countries of the world are less fortunate, however. The same coal which costs utility plants $8 a ton in the United States industrial centers, costs $22 a ton or more delivered abroad. Yet so fuel-short, so energy-hungry are other countries that English, Italian, and German industrialists—to name only a few—are over here trying to make 5 and 7-year contracts for this $22 a ton coal in quantity.

I know because I have talked to them.

It is the fuel-short, energy-hungry economies of these other countries—some already highly industrialized and some in process of industrialization—that atomic energy can make the difference between healthy growth and arrested development.

Right here is the crux of what I would like to say. It is in this imbalance that I see our challenge and our opportunity. We in this country are sometimes indifferent, sometimes hostile, sometimes prone to misuse to lesser ends the promise that atomic energy holds. But to the rest of the world, atomic energy looms in magnified perspective because it is the only real chance for a good life in this generation.

Whenever the United States drops some hint that we are ready to give atomic aid, the world response has surprised even those few Americans, like the members of this committee, who fully appreciate the power and scope of peaceful atomic uses.

There was initially such a response to President Eisenhower's atoms-for-peace plan, announced over 2 years ago. There was such a wave of enthusiasm when the United States pulled back the curtain of atomic secrecy a little bit at last summer's Geneva atomic conference.

Mr. Chairman, I remember discussing that with you and with Mr. Cole also at Geneva. Yet what concrete steps have we taken, Mr. Chairman?

These waves of enthusiasm show a basic fact about atomic energy. It is not just one more medium of economic aid or technical assistance. We can keep on giving conventional aid at the cost of billions, without lasting effect.

Today the United States is the most advanced Nation in the development of peaceful atomic uses. But we have learned once before, to our regret, that any lead in the atomic technology can be a transient thing. There is no law that the nations of the world must always come to us for atomic knowledge and equipment. On the contrary, there is an inexorable law of human nature that if men want something badly enough, they will go get it wherever they can get it. And we can be certain, with the new tactic of Soviet service with a Soviet smile, that it will not be too long before the whole range of peaceful atomic applications will be made available by Russia, even if not by us.

This leaves us with only one course of intelligent action—we must make a broad atomic-assistance program an integral part of our international relations.

Our panel recommended to this distinguished committee that the United States furnish nuclear fuels, give technological assistance, and permit contracts for the installation of at least 1 million kilowatts of atomic electric generating capacity outside the United States as soon as possible—we hoped by 1960.

These recommendations we presented to you gentlemen on January 30. On February 23, President Eisenhower set aside 20,000 kilograms of nuclear fuel for use at home and another 20,000 for use abroad.

But just making fissionable material available does not build reactors. Two years ago, the United States set aside 200 kilograms of nuclear fuel for research reactors to be built abroad. Yet today only one research reactor fueled with American nuclear fuel is in operation on foreign soil—the one we built, the one the Joint Committee saw, for the Geneva Atomic Conference and later sold to Switzerland.

HERE'S HOW

I would like to suggest a way for us to go about getting atomic power reactors built abroad. To make my proposal clear, let us first look at how we are doing it at home.

We now have under way here in this country a domestic power-reactor demonstration program. It is being financed partly by business and partly by Government. As part of this program, 7 plants totaling between 800,000 and 1 million kilowatts of electric-power capacity will probably be finished by 1962. The total cost to the Government and participating private business groups will be in the neighborhood of 300 to 350 million dollars.

Our panel report had this to say of the domestic demonstration program. Mr. Chairman, by your leave I should like to read a few paragraphs from the report, not because I don't think that you gentlemen have not read the report, but we spent a year hammering that on the anvil and we brought to bear what we thought was the best available opinion in the country on the subject:

For the growth of any nuclear-power generating capability to occur in the United States, it must be firmly based on technological knowledge, and in engineering and operating experience. The required technological, engineering, and operating data can come only from research, development, and construction of plants of experimental, pilot and full-scale size. This takes time. New accomplishments in fuel fabrication and reprocessing, as well as in the broad fields of chemistry, metallurgy, and physics are required. Experience of the past 5 years makes it clear that such developments can only be accomplished in an orderly way. Frequently they hold little immediate promise for private profitability, since there are as yet no markets in which such developments can be exploited. This is the fundamental reason why Government has had to bear the initial responsibility for exploration of this potential resource. As the day draws closer when economic feasibility can be foreseen, industry has indicated an ever-increasing willingness to assume a share of the responsibility.

Impact from atomic power can come from exploring this field technologically, as well as from its commercial application. Thus two different determinations, as yet not clearly embodied in Government policy, must be made as to the urgency of getting on with atomic power. The first relates to the need for or desirability of technological development of atomic energy as a power resource; the second, related to the first, involves the rate at which this resource should be commercially developed.

The prospect of an indefinitely expanding national economy which may require as much as 600 million kilowatts of installed electric-generating capacity or more by 1980 makes it clear that the Commission must explore this nuclear resource by a continuous program as promptly and efficiently as possible. In doing so it will be necessary not only to build pilot or experimental nuclear plants, but also full-scale demonstration atomic powerplants of each new and promising major reactor size and type. These are essential to permit development of the kind of engineering and operating data required for any intelligent decision as to how this particular resource can best serve the Nation.

Private enterprise should carry a substantial part of the burden of research and development, including construction and operation of full-scale demonstration plants. By "demonstration" we mean providing experimental and engineering data from which economic feasibility can be deduced reasonably. Where private enterprise does not assume the risk, we believe that the Commission should support expeditious development, if necessary, even up to and including construction of one demonstration plant of each major reactor size and type with public funds. In any event, we believe that continuing responsibility should rest with the Commission to encourage, and, where necessary, support basic research and development in this field. * * *

The demonstration plants now underway are exclusively large—over 60,000 kilowatt-plants. Taken together, they constitute an orderly and sound exploration of atomic energy as a power resource for large integrated electric utility systems in mature industrial economies.

An invitation has been extended by the Commission for proposals for small to medium-seized atomic-power demonstration plants. Such plants, on becoming economically competitive could constitute especially suitable power sources in the United States for small, nonintegrated or rural utility systems, and for single

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or remote industrial or mining power users. As a type, they would be far more suitable in many foreign markets than large-sized nuclear plants.

We recognize that small and medium-seized atomic power plants were thought less likely to be economically competitive at an early date, for technical reasons. The importance of such plants, however, on the international scene—as well as on the domestic—and the opportunity which they afford for a good demonstration of United States technological leadership give their development a high sense of urgency. The present development program is therefore deficient to the extent that appropriate demonstrations of the small and medium-seized types are not now underway.

May I read that last sentence again, Mr. Chairman:

We believe that—

The present development program is therefore deficient to the extent that appropriate demonstrations of the small and medium sized types are not now underway.

We said that in the panel report.

Now my own personal opinion, as one private citizen, is this:

Because there is no domestic shortage of fuels—because there is no domestic demand for electric energy that present conventional powerplants cannot supply much more cheaply there is no urgency in the United States to duplicate reactors of those types and sizes now proposed for demonstration.

But if there is any paramount urgency for pressing forward with a greatly enlarged atomic power demonstration program, it can only stem from the need for the United States to lead in bringing atomic power to the fuel-short energy-short regions of the world—regions in which the whole issue of our world leadership will be decided.

And more specifically to the point of these present hearings, I must emphasize that these regions abroad are the places where atomic power is most likely to pay its own way now, and, therefore, where atomic plants should be built now.

I have said "most likely to pay their own way" because none of the experts we worked with could say with any certainty what would be the actual cost of generating power in the first generation of plants now under design. Clearly, they cannot tell costs of the second generation of plants not yet conceived. Each of these experts, of course, can project detailed estimated costs of any particular plant design. But when you look at these calculations, you find they depend on many assumptions as to fuel, operating, maintenance and capital costs. Inherent in these assumptions are broad uncertainties which reflect the optimism or pessimism of whoever is using the slide rule. These uncertainties introduce into the sum total of these estimates errors large enough to offset any differentials which could result from tax-free operation or the reduced "amortization" rates of Government-owned plants.

I have changed that slightly from the text I gave you originally.

Chairman ANDERSON. Will you read it again?

Mr. MCKINNEY. These uncertainties introduce into the sum total of estimates errors large enough to offset any differentials which could result from tax-free operation of the reduced "amortization" rates of "Government-owned plants.

I have given a corrected copy to the chairman and to the reporter.

From this I have concluded that in this country, demonstration plants constructed completely at Government expense will involve two new burdens on all the taxpayers of the Nation.

1. Heavy initial outlays of capital to build plants which can never be amortized; and

2. Continuing outlays to subsidize deficit operations, continuing and perhaps increasing over the 20 to 40 years' operational life of the plant.

Abroad, however, where much higher power costs exist, present utility rate levels can come much closer to covering nuclear plant operating costs and to amortizing construction costs, and I believe this is to be subject to substantial proof without resorting to wildly optimistic assumptions.

There, I respectfully suggest to the Joint Committee on Atomic Energy that our national interests would be better served should the United States, together with those countries needing atomic power now, moving forward at once with an international atomic power demonstration program for the construction abroad of one atomic plant of each major type and appropriate size to be demonstrated in the United States, as well as other designs particularly adaptable to the needs of specific foreign regions.

THE COST

Let's look at the cost of such an international atomic power demonstration program.

Our domestic demonstration program, including development costs on the specific projects involved, will cost 300 to 350 million dollars. An international program of the same magnitude—that is, close to 1 million kilowatts by 1960—will probably cost about the same; higher foreign construction costs would be offset by the fact that development costs would be minimal.

Chairman ANDERSON. Before I forget it—you may want to return to it later anyhow—you just said up above at the top of page 13—

for the construction abroad of one atomic plant of each type and appropriate size to be demonstrated in the United States, as well as other designs particularly adaptable to the needs of specific foreign regions.

That probably would mean that we would want some of the plants which would use natural uranium and heavy water for demonstration outside the United States.

Mr. MCKINNEY. I read with great interest, Mr. Chairman, the testimony on Wednesday on that subject and between yourself and Mr. Cole and Mr. Zinn and others, and I thought it quite interesting. When I said appropriate size, Mr. Chairman, I had in mind that some of the very large plants we could use in our economy here might not be useful in other economies.

When I relate the cost of the domestic demonstration program to the probable cost of the foreign demonstration program and say it is $300 million, the higher construction costs abroad would be offset by the fact that development costs are already largely out of the way. This may sound like a lot of money, but our military and economic credits to Yugoslavia alone in the past 8 years total $1 billion.

The administration has asked for a foreign aid appropriation of $4.9 billion for the coming fiscal year. Compared to this, the cost of an international atomic power demonstration program over 5 years would be small—even in the unlikely event that the United States Government would bear the whole cost, and that none of it would be

repaid. Yet this program could salvage, it would make dynamic and productive, our $50 billion investment in foreign aid programs—military, economic, and technical. It could serve as the keystone for a new and effective structure of international policy.

By an international demonstration program, as I propose, we would certainly gain as much technological and economic information as we would get from an enlarged domestic program. Obviously, by doubling the number of plants of each type under demonstration we would increase only moderately the usefulness of the program in advancing recator technology and speeding competitive atomic power. Certainly we would by no means double the technological value of the program.

But in addition to and more important than technological data, the international program would prove to the world that we are vigorously moving forward to help those in need; that we are giving them our latest developments, not our castoff designs; and that worldwide application of peaceful uses of atomic energy are not being held back because our own needs for fuel, energy, and food are not as pressing as in other nations.

To Japan, the Philippines, Thailand, Pakistan, India, Turkey, to countries in the Middle East, to countries in Africa like Liberia, to countries in Western Europe, in Latin America, atomic power demonstration plants can mean many things. They can spell new hope for economic growth. They can be a symbol of cooperative effort which can dramatically demonstrate that there are more constructive relations possible between countries than uneasy coexisting or armed truces. Certainly they could do more good than any number of cease-fire agreements. They could offer to other nations the immense pride of taking part with the United States as copartners in the most inspiring challenge of our times—the conquest of the atom.

A 10,000-kilowatt atomic powerplant can go further in capturing the imagination of people around the world than a 100,000-kilowatt conventional plant costing many times more. It would be especially fitting as a start to build one in Liberia, that democracy which sprang out of our own founding principles.

With atomic energy, cost and size is not the criteria by which gratitude of other nations is measured. The measure is the pride it breeds in the minds of men for the present, and the hope it breeds for the future.

The local self-respect and self-sufficiency which will come from harnessing this new resource will bring new hope, new commonsense to many parts of the world where hopeless poverty and frustration now force national leaders into irresponsible positions against their own and the world's best interests.

It was in the United States that the first controlled nuclear chain reaction was achieved. It is in the United States that the greatest progress has been made toward harnessing this fundamental discovery. After having come so far in our development of the peaceful uses, we cannot now abdicate and let others bring them to mankind.

We must press forward vigorously with peaceful uses of atomic energy as a constructive new instrument in international relations. Otherwise, all our fine promises since we first used the phrase "atoms for peace" will have gone only to make headlines and consume news-

print. At our own invitation, the world will judge us as to whether "atoms for peace" was an advertising program without a product.

Our goal in expanding our atomic power demonstration program must be to bring other nations to the point where they can make sound decisions for themselves in the use of the new resource of atomic energy. We must, at the same time, help them acquire the physical means for carrying out these decisions. In atomic energy the United States must meet, first, these crucial problems that face us—the international ones—and then go on in seeking the solution of our longer range domestic fuel and energy needs.

I thank you, Mr. Chairman.

Chairman ANDERSON. Thank you, Mr. McKinney.

We have a rollcall over in the Senate and we may have to go over for a minute and then return.

Don't we have to show that we can make and use atomic energy at home at the same time at least that we try to make it available abroad? It would seem to me that the development costs of this program are not completely out of the way yet. Any plant which is built under the auspices of the United States abroad would have to operate well, without any question.

I though our Geneva reactor exhibit was wonderful, but we wanted to be sure before we went over to Geneva that our reactor would operate well and it did. I don't mean that we would have to wait equally as long, but certainly we want to make very sure that any plant we exported to a foreign country was a usable type, absolutely safe, without any possibility of disaster occurring as a result of its operation.

Mr. MCKINNEY. Mr. Chairman, that is an especially important point because if you expand the electric capacity of some foreign place where they badly need the power, they must be sure that it doesn't fail or they are right back where they started from.

Chairman ANDERSON. Have you some questions, Mr. Cole?

Representative COLE. Yes.

Chairman ANDERSON. You go right ahead.

Representative COLE. I want to compliment Mr. McKinney on his very fine presentation. I was a little disappointed where you referred to the fact that we had held out an olive branch of hope for atoms for peace but hadn't done much about following through on that branch.

Of course you recognize, as you indicated, the quizzical attitude toward the President's offer of 20,000 kilograms of fuel and then indicated the fuel wasn't worth anything without the reactor. Of course the opposite could be said, that nobody is going to spend money to build a reactor until they know they have fuel to put in it. It seems to me that the first thing we should be certain of is for them to know that they are going to have fuel.

Mr. MCKINNEY. I agree with you completely, Mr. Cole. I do not mean to be critical of our foreign demonstration program in the past. Until just now I think we have not been to the point where we can do that. The point which we were making about the present demonstration program in our panel report was with respect to the development of the smaller size plants which would be most useful in these foreign points. We were making the point that that was higher cost and more

difficult to do. I think the President's step in setting aside the 20,000 kilograms was the logical first step. I am now merely suggesting that we must take the second step.

Representative COLE. You will recall that that was a point of criticism that we heard at Geneva from the representatives of other countries.

Mr. MCKINNEY. Yes, it was.

Representative COLE. They said "What if we do go over and buy some of your atomic plants, what are we going to fire them with?" Britain hasn't given any indication of placing fuel on the open market. I think the procedure is moving along in an orderly fashion. I was disappointed that you did not place greater emphasis on the supplementary program which is being sponsored by our Government through the research reactors which are under construction or under way in various countries of the world. I speak of the one in Geneva which we left there. I am trying to recall with just how many countries we do have international agreements for cooperation in the field of research. I think it is 30-odd countries. So in the course of time research reactors will be built. One of the greatest deterrents to constructing reactors abroad is the lack of skilled people to run them after they are built there. With equal force we may say why should we build a reactor in a foreign country and let it stand idle due to the scarcity of skilled personnel to run it and operate it after we build it?

I agree with your suggestion and I think it is fine, but I do think we can do a bit of international disfavor by indicating that this new force is just around the corner and that all that is needed is somebody to decide. Of course the program is good, but it does require time to work out.

Mr. MCKINNEY. Mr. Cole, if I understand the testimony correctly which was given last week, the distinction was made between the value of research reactors, its very fine use in training personnel abroad, as distinguished from the fact that they were not a source of commercial power as such.

Next, I agree that the steps we have taken have all been sound, and what I am referring to is not the steps so much as the speed at which we proceed.

Third, what I am speaking to now is to the point of the present bill before the Senate, I believe S. 2725, with respect to doubling the demonstration program in the United States. I am just respectfully pointing out if we are going to double the plants now devoted to demonstration, there will be more advantage involved in constructing them abroad than here.

Mr. COLE. I particularly want to compliment you, Mr. McKinney, on your conclusion that the proposal for doubling our atomic power production just for the sake of generating electricity neither advances the art materially nor is it good sound economics.

Mr. MCKINNEY. That is right.

Representative COLE. I thoroughly agree with your conclusion on that score and I compliment you for presenting that viewpoint.

As a businessman, as you indicated, you devoted a year to study the impact of atomic energy on all phases of our economy, and your judgment as a nonprofessional in the atomic energy field is as good as anybody's. As good as mine or that of any other layman.

Since we are in agreement, I compliment you on the statement that you have made.

Mr. McKINNEY. Thank you.

Senator BRICKER. I have no questions, except that I want to join in what Congressman Cole has said. We appreciate the fine services you have given in the study which you have concluded.

Mr. McKINNEY. I must say, Senator Bricker, that these ideas originally started from that wonderful trip I had the pleasure of taking with the joint committee to Geneva and some of our long talks as we walked down the streets of Geneva in the evening. That town folds up very early, so we had the streets to ourselves for nice long walks and talks.

Representative COLE. Mr. McKinney, it occurs to me that if this Government embarks on a program as recommended in the bill under consideration and does nothing to carry out the overseas aspects such as you have suggested, we might run the risk of developing a considerable amount of ill will abroad directed toward us. Since it is well known throughout the world that we have an abundance of fuel and oil and coal, it would be indicated in starving countries of the world that we were doing this just to show that it can be done, but the place we selected to show that it can be done is not where it is needed but right here in our own continental limits where it is not needed for the purpose of generating electricity. It just seems to me that we are going to sow the seeds of further international discord and jealousy and envy.

Mr. McKINNEY. Mr. Cole, there was an economist who wrote in the early part of the century and who coined the phrase "Conspicuous waste." I think what you are saying is that such a domestic program would be conspicuous waste.

Representative COLE. And for that very reason it would be resented by folks who have such great use for the thing that we are wasting.

Mr. McKINNEY. Exactly.

Representtaive COLE (presiding). Thank you very much, Mr. McKinney. I am sorry more members of the committee were not here, but I am sure they will read your statement.

Mr. McKINNEY. It was a pleasure to be here.

Representative COLE. I hope you will be as persuasive on the other members of the committee as you have been of Senator Bricker and me.

Mr. McKINNEY. Thank you, Mr. Cole.

Representative COLE. The next witness scheduled for this morning is Mr. Iddles, president of the Babcock & Wilcox Co., who has given the Joint Committee the benefit of his counsel and wisdom based on many years of sound, hardheaded practical business experience.

We are glad to see you back again, Mr. Iddles.

STATEMENT OF ALFRED IDDLES, PRESIDENT, BABCOCK & WILCOX CO.

Mr. IDDLES. Thank you, Mr. Chairman.

Mr. Chairman and gentlemen, my name is Alfred Iddles, and I have on my left an associate, the assistant manager of the atomic energy division, Mr. John Landis.

I am president of the Babcock & Wilcox Co., with headquarters in New York and Barberton, Ohio, and manufacturing plants in eight different States.

Your committee has asked for suggestions for "accelerating the civilian reactor program in this country and for specific information on the status of private reactor projects."

The normal and effective way for developing practical answers to such problems as utilization of atomic energy for commercial use is to—

(1) Develop conceptual designs by the use of scientific information and laboratory experiments;

(2) Build and test pilot plants;

(3) Construct commercial plants large enough to determine actual operating results;

(4) After pilot plants and small commercial plants have been operated satisfactorily, build larger plants as may be required for the desired output.

The Government, through its several agencies, has done an excellent job in the development of conceptual designs of power reactors and in the construction and operation of pilot plants.

The submarine thermal reactor project, including the prototype installation at the National Reactor Testing Station in Idaho, and the powerplant which now propels the *Nautilus*, has, as you know, been an outstanding success.

The submarine intermediate reactor project, through the operation of the prototype installation by Knolls Atomic Power Laboratory at West Milton, N. Y., also gives promise of being successful.

The *Nautilus* reactor is a pressurized-water highly enriched uranium reactor while the reactor at the Knolls Laboratory is a sodium-cooled, partially moderated highly enriched uranium reactor.

Thus, the AEC and the Navy have already jointly proved out two very promising power reactor possibilities.

Furthermore, several major power reactor experiments have been completed and seven additional power reactor experiments are underway. Those which have been finished include:

(1) Experimental breeder reactor No. 1 (a sodium-potassium-alloy-cooled fast reactor fueled with highly enriched U–235 and with a blanket of natural uranium).

(2) Homogeneous reactor experiment No. 1 (a homogeneous reactor consisting of a circulating pressurized water solution of highly enriched uranyl sulfate).

(3) The borax series of experiments (boiling light water reactors with heterogeneous cores similar to the pressurized water core).

The reactor experiments now underway comprise the:

(1) Experimental breeder reactor No. 2.

(2) Homogeneous reactor experiment No. 2.

(3) Experimental boiling-water reactor.

(4) Sodium reactor experiment (sodium cooled, graphite moderated, slightly enriched uranium reactor).

(5) Organic moderated reactor experiment (diphenyl cooled and moderated, highly enriched uranium reactor).

(6) Liquid metal fuel reactor (circulating bismuth U–235 alloy, graphite moderated).

(7) Los Alamos power reactor experiments (uranium phosphate in water solution).

In order to best use the mass of reactor design information which has been and is still being accumulated in Government laboratories and by pilot-plant operators, the next logical step is to construct commercial plants which are sized in accordance with past experience and potential future applications. These plants may vary in size from reasonably small, say 5,000 kilowatts net electrical capability, to very large, say 200,000 kilowatts net electrical capability. In this connection, the Commission has decided—and I think wisely—that this is the point in the reactor development program at which private enterprise should be brought into the picture, as suggested and authorized by the Atomic Energy Act of 1954.

Two avenues of approach have been set up. The first is through the power demonstration reactor program in which a portion of the research and development costs involved will be borne by the Government. In the first phase of this part of the program:

(1) The Power Reactor Development Co. has proposed to build a fast breeder reactor based on experimental breeder reactor technology.

(2) The Consumers Public Power District of Nebraska has proposed to build a sodium graphite reactor based on sodium reactor experiment technology.

(3) The Yankee Atomic Electric Co. has proposed to build a pressurized water reactor based on the knowledge which has been accumulated in the submarine reactor and the Shippingport reactor programs.

Other persons will no doubt be reporting to you on the present status of these three projects. I assume that they are forging ahead.

In the second-round power demonstration reactor program, 7 proposals for 7 different types of small-scale reactors have been presented to the Commission and 2 of these have already been approved for negotiation.

These reactors are for the most part based upon results of the AEC's 5-year reactor-development program.

The second avenue of approach is that of a purely commercial venture financed entirely with private funds and requiring only a license from the Government. In this category, which I believe to be the best indication of the initiative being displayed by private industry in this new field, construction permits have already been granted to the Consolidated Edison Co. for a pressurized water thorium converter reactor and to the Commonwealth Edison Co. for a boiling-water reactor, both large scale. Two other projects fall in this category but have not yet developed to the point of hazards evaluation and license application as of this date. They are the Pennsylvania Power & Light aqueous homogeneous reactor project and the Florida Nuclear Power Group high-temperature reactor project. Again, these two plants are large scale.

In my opinion, the parallelism of the large-scale projects with the reactor design concepts being developed and tested by the AEC is a sign of healthy cooperation between Government and industry in the nuclear field. It is a sign that progress is being made in the normal way, and I believe as fast as possible under the circumstances.

Chairman ANDERSON. Do you have any objection if there is not parallelism? As was brought out in the testimony, as I assume you are aware, there are types being tested which seem to offer some possibilities; for example, the gas-cooled type. Do you think that should or should not be tested?

Mr. IDDLES. Any promising type should be tested. The gas-cooled one that you have referred to, Mr. Chairman, is I believe on the way.

Chairman ANDERSON. Where?

Mr. IDDLES. Has there not recently been authorization for a gas-cooled, gas turbine reactor installation?

Mr. JOHN LANDIS (assistant manager, atomic energy division, Babcock & Wilcox Co.). With your permission, Mr. Chairman, I might speak to that, or Dr. Zinn probably knows more about it than I.

Chairman ANDERSON. He says it is a small test.

Mr. LANDIS. It is one of the latest reactor proposals in the so-called second round of the power-demonstration reactor program for a gas-cooled, closed-cycle reactor. This is the one proposed by Holyoke.

Chairman ANDERSON. Just tell us when it was approved.

Mr. LANDIS. I did not say it was approved, but proposed.

Dr. ZINN. I believe, Mr. Landis, you will agree that that is a small plant using a gas turbine. I think you will also agree that for fairly large-scale commercial power the gas turbine is not now really a practical device. I agree 100 percent. I think what the chairman had in mind was the fact of the possibility of building a large-scale gas-cooled reactor using a steam cycle. It is being pursued by both the British and the Russians. It is that type of reactor rather than the high-temperature gas-turbine device which is still in the development stage.

Mr. IDDLES. I think your point is well taken, Mr. Chairman. I have that later in my discussion for brief mention with respect to what they are doing in England.

Chairman ANDERSON. I appreciate that you are testifying on the Gore bill and that what you have just said is pertinent to the Gore bill.

The Gore bill may provide and probably does provide parallelism and we will have discussion as to the variability. I tried to go a little beyond that and say, somewhat along the line that Mr. McKinney was saying earlier, that if we might have objection to the parallelism, would we have objection to testing out promising patterns that are not now being tested for power. The other day in the course of the discussion Dr. Zinn outlined different types that might profitably be pursued, that are not now being pursued. Must we tie everything to the so-called *Nautilus* type?

Mr. IDDLES. No indeed. It is my impression that a very large proportion of the potential types that have been conceived of are being worked on either by AEC in their laboratories or by pilot plants or by industry.

Chairman ANDERSON. That is the question we raise. Are they? We have been working with a homogeneous type of reactor down at Oak Ridge but no private company is ready to move into that field. It has been announced that if the results at Oak Ridge work out fairly well by 1958 the Pennsylvania Power & Light will then make a decision as to whether it thinks it wants to go ahead. That isn't too definite as yet, is it?

Mr. IDDLES. No, and my company hopes they will be ahead of the Pennsylvania Power & Light job because we are working on it, too, very, very actively.

Chairman ANDERSON. That is our idea of American enterprise, isn't it?

Mr. IDDLES. That is right. But my parallelism remark referred particularly to the desirability of working with the laboratories now under the control of the Atomic Energy Commission in parallel so that industry can bring to bear its knowledge and know-how to the Government laboratory work.

Chairman ANDERSON. Has industry proposed other types which previously have not been financed by the AEC?

Mr. IDDLES. Not that I am aware of, sir. There are modifications of those which industry conceives of and, in fact, talks over with the laboratories. We have been talking recently to the Oak Ridge Laboratory about a quite different modification of the homogeneous aqueous reactor in an attempt to solve the momentarily very difficult problem involved in the technology.

Chairman ANDERSON. I only want to say—I may be alone in my feeling on this committee—that I don't know whether we have had any attempt to find out where we stand on these various things. We are trying to explore them. It would be my feeling that if we had at Savannah River reactors which had been quite satisfactory for the production of plutonium and we had testimony that these reactors could be adapted to the production of power, either primarily for the production of power or for the joint production of power, there should be testing of that power resource. It might not appear desirable but it might prove to be very desirable indeed.

Mr. IDDLES. I agree with you.

Chairman ANDERSON. That is what we have been trying to examine.

Mr. LANDIS. If I might add a word, Mr. Chairman, with your permission.

Chairman ANDERSON. This is a wide open discussion. I hope you will continue to add words whenever you desire to do so.

Mr. LANDIS. I think what Mr. Iddles is trying to get across is that this parallelism stems from a consideration of the logical way to develop complex systems such as nuclear reactors which he outlined on the first page or two of his testimony. It does not mean that industry is not going to exercise ingenuity and initiative in coming up with new designs. It does mean that there will have to be cooperation between the national laboratories and industry if the most efficient development of atomic reactors is to take place, because industry does not yet have at its disposal all of the facilities that the Government does, and perhaps vice versa.

So there must be close cooperation between the two, I should think, to the benefit of the country as a whole in this particular field.

Chairman ANDERSON. You may proceed.

Mr. IDDLES. My next paragraph leads into that same question in a different way, Mr. Chairman.

We at Babcock & Wilcox Co. are not aware of any conceptual designs of still different reactors which are clearly ready for immediate development and construction for commercial use at this time. That is not to say there are not conceptual designs that we don't know about and perhaps should.

Chairman ANDERSON. Would you permit me to ask Dr. Zinn to go over some of the ground he went over the other day, of designs that are not too far away?

Mr. IDDLES. I would be delighted.

Dr. ZINN. I think the point I made the other day was predicated by the statement that we must assume that it already has been decided that there will be further expansion of fairly large-scale reactor construction.

The question was: Are there any types of reactors which are not now being actively pursued for fairly large-scale construction? The thought comes to mind immediately that at Hanford we have a type of reactor with which we have had many years of large-scale experience but which is not now in our program for power reactors. Yet the possibility of adapting that reactor to power generation does not require a terrific imagination. I want to emphasize the fact that there lies our largest experience.

Similarly when we look at the Savannah River reactor we see another reactor with which we have had considerable experience, which furthermore makes use of the material, heavy water, of which we are the world's leading producer and perhaps really the only producer at a phenomenally low price.

Furthermore, heavy water has the possibility of allowing power reactors to operate on natural uranium, a possibility of extreme attractiveness to foreign countries that do not want to be tied to the import of enriched uranium.

Both of these types, one would note, differ from most of the power reactors using water which are being exploited in this country in that they do not use a large-scale pressure vessel which ultimately may be a limit to the size of our power reactors. They use the individual pressurized tube approach and actually none of the reactors in our demonstration program using water use the individual pressurized tube approach at the present time. This is a hole in our program.

I also pointed out to the committee that the very first reactor design proposed in this country for any purpose on a large-scale was a gas-cooled reactor. This was in 1942. It was a design which carried through the drawing stage actually. It was superseded by the Hanford type. Nevertheless, you have to confess that a gas-cooled reactor holds out the promise of high temperature, and as power engineers I think we all agree that high temperatures are highly desirable in order to get cycle efficiency and that perhaps reactors of high-cycle efficiency will ultimately all supersede the water reactors, which are perhaps doomed to have low-cycle efficiency.

Along the same line I think I pointed out that we have only one type of sodium cooled power reactor used for moderation, and perhaps this is too little for another type of reactor which has the possibility of high-temperature and high-cycle efficiency.

It was along this line that I spoke last week and which the chairman has asked me to repeat now.

Mr. LANDIS. If I might say a word there again, with your permission, Mr. Iddles, as Dr. Zinn probably knows better than we do, there are certain difficulties with respect to taking the so-called Hanford design and the so-called Savannah River design and making them over into power producers. For one thing, both reactors are operated at low temperatures and low pressures. To make the Hanford-type reactor

into a power producer you have got to increase the pressure of the water in the primary cooling system significantly. This means that you have got to introduce into the reactor core sizable quantities of structural materials. We have looked at that reactor, have computed how much structural material we would have to put into the core, and have decided, perhaps wrongly, that this reactor is not as attractive economically as is a straight pressurized water reactor.

With respect to the Savannah River type reactor we have felt that this is a reactor we will want to develop some day. We have not done so to date because it has not been until recently that the heavy water cost picture has cleared up.

Secondly, heavy water, as you know, even at the lower costs recently quoted by the AEC, is still fairly expensive, so you don't want to waste it. So you have got to develop new components, you have got to develop remote handling equipment to take care of fuel removal in a different way than you do with pressurized light water systems, and so on.

There are many problems. As I say, you undoubtedly know them better than we do. On the basis of these problems, we have decided that the other reactors being developed in the AEC's program are perhaps more attractive economically than are those that have been developed in the production program.

Dr. ZINN. Mr. Chairman, I just want to remind you that here again we are talking about estimates of the first choice and second choice. Everyone I think will agree that only ultimate construction and operation will really prove whether the estimate of first and second choice was correct.

Mr. LANDIS. That is right. I would be first to agree with that.

Mr. IDDLES. I am sure, Mr. Chairman, we appreciate that, and we are very humble in that area, knowing of Dr. Zinn's experience. I should like to remark that we do not operate on the basis that something cannot be done, because I long ago learned that in the engineering world you can't say that. The world and its technology changes.

I was saying that we were not aware (perhaps we should have been) that there are reactors clearly ready now for immediate development and construction for commercial uses. It would be better from a commercial and engineering standpoint to wait for the pilot-plant information which will shortly be forthcoming from the various government projects I have mentioned before attempting more in the way of full-scale reactor construction.

Obviously that remark does not apply to the reactors which Dr. Zinn has just mentioned.

If a program for building six more (on p. 5) commercial reactor plants is undertaken at this time, it is my opinion that their drain upon available manpower and critical materials would be severe and undesirable. The shortage of manpower in this field is common knowledge and I believe that the manpower which is available should continue to be used on the projects already underway and on the pilot plants and research work in connection therewith. Nickel and zirconium are already in short supply and would probably be needed in large amounts for such new projects.

Chairman ANDERSON. Couldn't that same thing have been said some years ago when we started to get into the development of these powerplants with the aid of private industry? Couldn't the charge have

been leveled against Babcock & Wilcox that you started to recruit people? How many engineers did you have 3 years ago competent to operate in this field, or 5 years ago?

Mr. IDDLES. Five years ago we had about 1, and 3 years ago about 15.

Chairman ANDERSON. Did you recruit manpower to get the present staff you have?

Mr. IDDLES. If you will look in the Sunday edition of the New York Times for those who are looking for engineers in this field, including of course the defense projects on rockets and so forth, it is becoming increasingly difficult.

Chairman ANDERSON. Surely.

Mr. IDDLES. We should, I think, apply our manpower to those things which are the most promising and not go off on a duplicate of something already underway. That is the point I was really making.

Chairman ANDERSON. I am just wondering if some of the things to which we are applying this manpower are the most promising.

Mr. IDDLES. That may not be, sir.

Representative COLE. Who is to say?

Chairman ANDERSON. We might find that something else works. The Russians seem to be pretty well satisfied with their program and they are building some different types of reactors. We keep holding on to this one that we know works, hoping that everything else will conform to it. It might not. The British are making pretty good headway with their type.

Mr. IDDLES. You are referring to pressurized water?

Chairman ANDERSON. That is what we are holding to. The British are going ahead with a gas-cooled plant.

Mr. IDDLES. Babcock & Wilcox are spending almost all their energy (aside from building a large commercial plant which is pressurized-water type), on two radically different ones; one in particular meeting Dr. Zinn's point, the liquid metal fuel reactor in which we hope we will be able to produce high pressure, high temperature steam which is highly desirable from the overall efficiency standpoint.

Chairman ANDERSON. I could not fail to commend you for doing that. I think that is fine. I wish there were many other avenues by which you could continue that. I would like to think, if you got something that looked pretty promising, the Government could not resist the temptation to enter into another contract such as the Shippingport contract, even though it knew that the first development of it was rather high priced.

Mr. IDDLES. If I may I will cover that point just a little later here in my testimony.

I want to emphasize that development work does not stand still, however, while pilot plants are being built and operated. All of the basic designs which the AEC has promulgated to date are being studied by various industrial groups with excellent cooperation from the AEC laboratories, with the intent of developing practical designs as rapidly as piecemeal information is obtained from the laboratories (both governmental and industrial) and the pilot plants.

For instance, my company has studied for the past year, and is continuing to study, a large-scale homogeneous reactor installation for the nuclear power group. That is the group now building the boiling reactor in this Chicago territory. We hope that this may be developed into a breeder reactor. Laboratory information on the prop-

erties of structural materials is vital to continued progress in this project and is being developed with great vigor by the Oak Ridge National Laboratory and by several industrial companies, including Babcock & Wilcox.

The AEC Selection Board has notified the Babcock & Wilcox Co. that it has been chosen to design, construct and operate the liquid metal fuel reactor experiment for the Government. This contract is now being negotiated. We plan to carry forward with the design and construction of this experimental reactor a separate and independent study with our own funds of how the pilot-plant design can best be made into a full-scale commercial installation if the pilot-plant results are satisfactory.

That is directed to our point. Just as quick as we feel reasonably sure that that is worthy of following up we are willing to build that big plant.

Chairman ANDERSON. The group which was in here said that I believe your company and Allis-Chalmers had contracts to work in this same pattern, but this is the Brookhaven operation, isn't it?

Mr. IDDLES. It originated in Brookhaven with a great deal of assistance from Babcock & Wilcox Co.

Chairman ANDERSON. I am not trying to detract from any assistance you gave them, but there have been suggestions of that nature developed all over the country. The difficulty with the present program, as I see it, is that only unless some group like the Florida group says "We think we like the looks of this thing" do the private companies come up and say "We will build something on it"? The selection, the choice, the determination of every-type is left in the hands of the private companies. If the Government thought it had a very interesting program it can't do anything about it under the present law.

Mr. IDDLES. Maybe it should change the law and be able to. I still believe, however, that progress is likely to be very good if it is left in the hands of industry.

Representative COLE. The Commission does not have authority now to construct any type of power reactor that it wants to?

Chairman ANDERSON. For research and development purposes probably it can. Maybe I should say that it doesn't at the present time and leave it that way. I know Mr. Cole tried very hard to get the law so it could be done that way. We hoped it could be done that way. My only thought is that the sole determination of choice and decision as to what type should be built seems to rest in the hands of private industry, and if private industry decided that it does, and I assume it does, want to take its time about putting anything in the field that might compete with conventional power, it has the power to do so.

Mr. IDDLES. I assure you there is no intention on the part of any utility or big industry that I know of to postpone the development of atomic power to protect a commercial and conventional plant. That definitely is not our desire.

Chairman ANDERSON. It may be desirable to go ahead with some of these promising types a little more rapidly than we are now doing, keeping somewhat in pace with what seems to be going on in England and Russia and elsewhere.

Mr. IDDLES. That might be desirable, although the profit motive always comes to the fore and these companies of course are seeking

that which is nearly or, if possible, actually commercially desirable.

Chairman ANDERSON. In the Shippingport project the actual cost, including development cost of the reactor portion would be about 90 million of which they were going to put up $5 million. That is a fair share from the standpoint of the Government; isn't it?

Mr. IDDLES. Yes.

May I ask Mr. Landis to make a remark which he has in mind?

Mr. LANDIS. Mr. Chairman, I think your remark about the private industries making the sole decisions in this field goes back to what Mr. Iddles said earlier, namely, that this development is a process of close cooperation and step by step progress on the part of both industry and the Government and that any decision which industry is likely to make with respect to what type of reactor they want to build or further develop will be colored greatly by what the AEC has done to date.

Obviously the Florida power group, while it does have a great desire to develop something which is perhaps better than has been developed to date, is not going to disregard the recommendations of those people in the Commission who have devoted years of work to this field. In taking the recommendations of the AEC they are certainly going to profit by all the work htat has been done in the AEC laboratories.

Chairman ANDERSON. I am not talking about pilot plants. I am talking about large-scale development. I would be interested to know who in the AEC determined on this Brookhaven type of reactor in Florida.

Mr. LANDIS. I don't think any one in the AEC, Mr. Chairman, actually made the final decision. What I am saying is that the AEC has made information available to private industry, to every one in private industry, and we all have the chance, if we want to, to make a decision to use a certain reactor type. It does take courage since you are spending millions of dollars. But these decisions will more likely be made by a greater number of companies if the broad-scale AEC program which has been started is permitted to progress with as much manpower as possible in cooperation with the projects that are now under way in the industry.

Chairman ANDERSON. I am not an engineer and can't state it as Dr. Zinn stated it, but he did point out that one of these reactors at Hanford had some possibilities, and that the higher temperature-type reactors seem to offer the possibility of lower costs. The Shippingport reactor when it is finished offers the possibility of a cost of about 50 mills.

Mr. IDDLES. That is not very good.

Chairman ANDERSON. I know it isn't, but it would raise a question in someone's mind as to why we stay with 50 mills and don't try a pattern which seems to offer the possibility of lower cost. Nobody wants to develop anything of the Hanford type. You pointed out a moment ago that it has some engineering problems which still have to be settled. I understand from Pennsylvania Power & Light that the one they wanted to build had some engineering problems still to be settled.

Mr. IDDLES. They do.

Chairman ANDERSON. What would be wrong with trying to solve the engineering problems in connection with the Hanford reactor if devoted to power?

Mr. IDDLES. I think your point is well taken. I want to say we spent about 6 months trying to help the General Electric Co. and the Commission figure out a way to make the Hanford thing commercially successful and it was turned down by someone in the Government as not being economically desirable.

No doubt, we should go back to that again.

Chairman ANDERSON. I have been trying to find out what that proposal was. I thought it was rather attractive. It was turned down. I wonder if the real reason was that it wasn't economically desirable?

Mr. IDDLES. Our participation was that of supplying the estimated cost of a considerable portion of the equipment. I don't know what the overall economics was except that it was officially turned down.

Chairman ANDERSON. I thought it was a fine idea, to be honest with you. I don't know that I would have thought so then. I am not trying to go back and have better judgment now than somebody had then, because we didn't know then how rapidly the industry would develop in Russia and the development in other parts of the world. But now we do know that Russia is making great progress in the construction of these plants, even though their economy is a wholly different economy from ours.

I am very hopeful that we don't overlook any bets. I don't say the present bets aren't good ones, but I say there might be some other horses that might still be running and I would like to place an occasional bet on one of these.

Mr. IDDLES. You are quite right, sir, and also you must look the horse over each time he enters the race.

Chairman ANDERSON. As long as Hanford has more reactor history than all the rest of them put together, I wouldn't worry too much about starting off on that theory.

Mr. IDDLES. That is correct. It is the economics involved that enters into the picture, I believe.

Mr. LANDIS. Mr. Chairman, is it not also a problem of manpower? We, like every other company in the field, have limited manpower resources upon which to draw. We have decided that it is much better for us to be working on a reactor which puts us ahead 10 years from now rather than puts us ahead perhaps 2 years from now and behind 10 years from now and forever after that.

Chairman ANDERSON. That is fine if General Electric, Westinghouse, and Babcock & Wilcox are going to do everything in this field for the next thousand years, but there are other companies in this country. Even you would have to admit that. There is a small company that went down to the Savannah River, call the DuPont Co. It built the plant at Savannah River. What would be wrong with trying to talk to some of the people who have worked steadily in the DuPont industry on the Savannah River plant? In addition to this supervision, they have manpower already in their organization at Savannah River. Why not let them try to find out how the Savannah River plant can be adapted to power.

Mr. LANDIS. That would be an excellent suggestion, Mr. Chairman. I don't wish to discourage that.

Chairman ANDERSON. That wouldn't drain your manpower any; would it?

Mr. LANDIS. It would not. We are only speaking, of course, of the manpower situation as we see it within our own company.

Chairman ANDERSON. If you were going to allow all development to be done by three companies, then I realize manpower is a great problem.

Mr. LANDIS. I had no intention of indicating that there would be only three companies in this field. As a matter of fact, I think there are probably 40 in the reactor manufacturing field already.

Chairman ANDERSON. I am not trying to insist that you claim that you did. You didn't of course. I do think that you look at it a little bit from the standpoint of how difficult it is for you to obtain additional manpower, and so does Westinghouse and so does General Electric, but along with it we have succeeded in developing some of these plants. Union Carbide has done a fairly good job at Oak Ridge. What would be wrong if Union Carbide decided to help a little bit in the development of the aqueous homogeneous type reactor down there? It has some possibilities.

Mr. LANDIS. Union Carbide of course is helping Westinghouse in the development of the aqueous homogeneous reactor for Pennsylvania Power & Light, and they are helping us with respect to the chemical processing problems on the liquid metal fuel reactor experiment. What else they can do of course I don't know. Our testimony of course has to do with only the B. & W. Co., and after you have heard all this testimony I presume that it is your aduty to synthesize something out of it that we are not able to see from our rather cloistered position.

Chairman ANDERSON. You are acquainted I guess with Alvin M. Weinberg, Director of Oak Ridge Laboratories. He made a speech at the atomic industrial forum on April 19, 1956, and not being an engineer I have to get some comfort out of his expert testimony. It is at page A3884 of the Congressional Record for May 14.

> As I said, we have in this country 4 or 5 firm proposals for large-scale power demonstration reactors. In order really to meet the foreign competition—and I refer to foreign competition with respect to using nuclear energy as an instrument of national policy—I believe that a country as large and strong and vigorous as ours should have several more large-scale propositions actually underway.

He is my witness. Why is it that we should not have them under way? That is what I want.

Mr. IDDLES. He is a very good witness, sir.

Chairman ANDERSON. I think so, too.

Mr. IDDLES. I have a little more discussion on that general subject, however.

Representative COLE. If I may break in at this point, Mr. Chairman, I would like to inquire of Dr. Zinn if in his judgment the British atomic scientists and the Russian scientists have in their drawer of reactor concepts the variety of conceptions that we have in ours.

Dr. ZINN. I think the situation is quite clearly understood. We had last summer more variety than either. We know that the British have been trying to lay on, if I may use that phrase, as much of our program or parallel to our program as they can manage. It seems to me they are sincerely trying to imitate our programs, and admit it. The Russians haven't of course said this, but it is apparent from their latest paper, the paper by Mr. Kirchakov, that they are putting under construction actually reactors of every type that we are working on essentially, plus a couple that we may not be actively pursuing. I think

this is new in their program. I didn't discern this as an actual program last summer.

Representative COLE. Is it a fair conclusion that the type of reactors that are underway in both England and Russia are the only ones they knew about at the time they started them and they were types that our people did know about and types which our people had considered and laid aside in preference for some other better type. Is that a fair conclusion?

Dr. ZINN. Yes, sir. It is true to conclude that most countries have pushed further the type which really accident put in their hands. For instance, the British hadn't any choice really but to pursue the natural uranium graphite path, and that would be gas cooling, because the framework in which they made the decision in 1947 was such that they could not really choose anything else. Similarly the Canadians are pursuing very successfully I believe the heavy water approach because during the war that was the part of the program which the United States and Canada decided should be the Canadian province. I don't think the same thing is quite true of the Russian program. I think they had the same wise choice we had right from the beginning because very early apparently they built plants for enriched uranium, which broadens your choice right away. It doesn't necessarily follow of course that long continuous application to one of these choices which are forced on you, such as the British and Canadians had, won't lead to success. There is nothing that says they do not have a good basis for proceeding.

Representative COLE. Thank you.

Mr. IDDLES. I am reasonably familiar with the development of atomic energy for commercial use in Europe and England, and it seems clear to me that none of these developments is in any important way ahead of development work in the United States. The relative non-availability of U-235 in England and Europe poses quite a different problem than we have in this country. As a result, they are pursuing more vigorously than we the development of reactors using natural uranium as fuel. But it should be pointed out that such plants are not as economical as plants which utilize enriched fuel, and, in any event, do not involve any significant improvements not known to us in the United States.

Chairman ANDERSON. I would like to have Dr. Zinn comment on that because you say it should be pointed out that such plants are not as economic as plants which utilize enriched fuel, but I was given to understand that the reactor type which uses enriched fuel uses a relatively expensive type of fuel, that the operation of the gaseous diffusion plant is an extremely costly operation, and that a country like England which didn't have a gaseous diffusion plant wouldn't think of starting afresh to try to develop one, that the thing we do is the most expensive.

As a matter of fact, there was an article in a magazine a short time ago about the fact that the French were trying to develop a poor man's approach, that our enriched fuel approach was the rich man's approach, the prodigal uncle who could spend anything he wants done and the French couldn't afford it. I am very much interested in that statement.

Dr. Zinn, would you agree that these plants are not as economical as plants which might use natural uranium?

Dr. ZINN. No. I would not make a categorical agreement with that statement. I would rephrase the statement this way: That these plants, namely, the ones that use natural uranium, are technically not as easy to build as powerplants which use enriched fuel. I think if you saw your way clear to make technically successful the natural uranium plants, the economic picture might very well match or supersede the enriched fuel.

Of course we have to remember, Mr. Chairman, that our production of enriched fuel is again phenomenally cheap because we have had, I believe, to build large-scale plants for our military uses, but I don't think per se that enriched fuel is a cheap fuel.

As a matter of fact, I think it is easy to show studies which, if you would discount all of the other engineering features, would show that the enriched fuel is not the cheap fuel. On the contrary, it is more expensive than natural fuel. I will confess it is a complicated subject. You have to discuss the whole plant and all its engineering. As a categorical statement, Mr. Chairman, I could not agree at this point.

Mr. IDDLES. I will accept that criticism by enlarging the definition of the word "economical," which I used, and point out that the fuel per se may be cheaper, that is, the heat in the fuel may be more cheaply obtained from natural than from U–235, but the cost of building the plant to utilize that heat is out of this world as far as we are concerned in this country.

Chairman ANDERSON. We had a discussion with reference to the type of powerplant which would have to be put in a nuclear powered merchant ship if we were to build it at once and rush it through to completion. I would have to go dig up the testimony of Admiral Rickover but I believe he said, subject to mistakes of a very bad memory, that the cost of operating the enriched fuel type of small powerplant was so high that it would not be the ultimate type that could be used on merchant ships. It was just very expensive.

Mr. LANDIS. Of course, Mr. Chairman, Dr. Zinn has probably mentioned this, but just for the record I think we ought to say that Admiral Rickover was undoubtedly referring to a core which is made up of only enriched uranium, and no fertile material. What we have in mind here is incorporation of fertile material in the core so we get the advantage of some conversion and the creation of new fuel, offsetting partially the high cost, as Dr. Zinn has pointed out, of the U–235 inserted originally in the core. As he has pointed out, this is a very complex picture. We have tried to analyze it on paper. Because this has been only a paper analysis based on operation of Government reactors, perhaps we have been too dogmatic and we should say such plants appear to be not as economical, but these have been the results of our paper studies to date and of course we are allocating our effort and manpower in accordance with the results of these studies.

Mr. IDDLES. They in England must think it is a bit uneconomic too because I have them swarming around my place asking how we are going to do it in this country, and they are admitting that they are not too happy about their economic results.

The United States is not short of kilowatt-hours as is England and much of the rest of the world. What we need is cheaper power in some areas and an assured future supply to provide for our growing

requirements as the decreasing supply of fossil fuels becomes more important.

England's major step forward is probably in its proposed plutonium breeder reactor, very similar to the 100–150,000-kilowatt plant that is now being designed by the Power Reactor Development Co. in the United States. Preparation of the site for this plant is now under way near Monroe, Mich. This plant will undoubtedly represent a significant advance in reactor technology because it will be producing fuel for future reactors at a rate substantially equal to its consumption of fissionable material.

Parenthetically, that is what I believe England is now talking about doing and has been over here to investigate.

Dr. ZINN. Could I add they apparently have decided to pursue both the sodium graphite approach and the pressurized boiler approach, giving the sodium graphite priority. That seems to be their present intention.

Mr. LANDIS. In addition to the fast breeder reactor; yes.

Mr. IDDLES. The point is that they are thereby not entering into a field which is not already well considered in this country. Isn't that right?

Dr. ZINN. Yes. Of course having one approach of their own, which we do not have, probably.

Mr. IDDLES. That we should consider and if that is better we ought to be following it. The chairman and you, Dr. Zinn, are exactly right on that point.

Dr. ZINN. I think the chairman phrased it the other day by saying a good second choice might still be something worth looking at again.

Mr. IDDLES. Specific information concerning the status of the Consolidated Edison reactor at Indian Point, which my company is designing and will construct, will, I understand, be presented separately to the Joint Committee by representative of the Consolidated Edison Co. and the Babcock & Wilcox Co.

I say that because your telegram asked for specific information and I am saying it will be forthcoming elsewhere.

No doubt specific details of the present status of the other projects already authorized will be presented by the designers or the owners or both.

There are two improvements in the conduct of nuclear power business which I recommend for your consideration. This is in answer to a specific question which you asked:

1. Earlier treaty arrangements and more specific regulations concerning the sale of American designed and constructed reactors for power production in foreign countries. This would provide United States equipment manufacturers with the same economic incentives now available to equipment manufacturers outside of the United States where conventional fuel costs are relatively high, and therefore where atomic powerplants are economically justified even with today's designs and operating experience. In my opinion this would stimulate nuclear power activity on a more natural basis than would a decision to build a large number of plants immediately in this country.

2. As regulations are developed and experience is obtained, we hope that approval of designs and the issuance of licenses by AEC can be accelerated. This would save considerable time in the course of future work.

In conclusion, I would like to summarize what I consider to be the main points of my presentation:

1. The United States reactor development program is proceeding on a broad front and in an orderly fashion.

2. No serious gaps with respect to development of basic technology are evident at this time.

I might have altered that slightly had I been talking with Dr. Zinn before today.

3. The civilian reactors proposed by industry include all of the types now ready for trial in commercial applications. Perhaps this too should be modified in the light of Dr. Zinn's remarks.

4. Construction of duplicates of civilian reactors—I am emphasizing duplicates—already under way would be a waste of manpower, critical materials like nickel and zirconium and money.

5. Premature construction of large-scale versions of advance concepts might be a serious hazard to industry and to the public.

6. In the long run, most progress is made in a field as complex as this by coordination of the activities of the various organizations and agencies involved and by extrapolating from the known to the unknown in a logical way.

I appreciate this opportunity of presenting our views to this committee and I assure you that we are open to suggestions and willing to cooperate with others in furthering this important activity.

I would like to add that I have not attempted to cover the question from the standpoint of international diplomatic relationships with other countries. That is out of my field. But I am quite familiar with France, Holland, Germany, Belgium, and England, and incidentally Japan and Australia, and either they are overly supplied with curiosity or they really don't have as much as we do because they are constantly over here looking for help and we are interested not only in our domestic activities but in doing some of that work overseas.

Chairman ANDERSON. Thank you very much, and thank you, Mr. Landis, also, for being here this morning.

Senator Jackson has a question.

Senator JACKSON. I have just one question: As a matter of fact, unless there is a substantial subsidy for the reactor program here in the United States, don't you feel that the best market so far as American industry is concerned will be abroad, where you have high fuel costs and where there are power shortages that make possible the reactor program?

Mr. IDDLES. That is quite so. I spent all day Friday with two gentlemen from Germany where they tell me they are producing power with $30-a-ton American coal and they are extremely anxious to have an atomic powerplant which we are proposing to build for them in Western Germany right now.

Chairman ANDERSON. I think that is important because Russia is talking about building one in East Germany.

Senator JACKSON. I think it is a very important part of the program, Mr. Chairman, and American industry will obtain invaluable experience which will inure to the benefit of our own country as well as of the people who will be served by that power.

Mr. IDDLES. One way of pushing that along is for the United States to make the proper arrangements with West Germany to permit that.

Senator JACKSON. I think the present picture is a bit confusing. We have announced a large amount of U–235 will be available, but that is only the fuel, and there is very little coordination and direction to the construction of the plant and how that is going to be accomplished.

Mr. IDDLES. That can be accomplished fairly easily. At the moment we need a treaty which covers the power reactors as well as the research reactors.

Senator JACKSON. I know, but our program up to now has been entirely on the research end of the thing. We have not talked about exporting the energetic atom to provide energy on a commercial basis.

Mr. IDDLES. I am suggesting that the United States do that more actively. We have a proposal in now for 10,000 kilowatts in Germany and 10,000 kilowatts in Switzerland, and none of them could go ahead at this moment without further activity on the part of the United States. The designs are done.

Senator JACKSON. Isn't this one area where we can dramatize the fact that American industry and our industrial complex is much more effective than the Soviet Union's in that we can carry on a large-scale construction program abroad supported by the know-how that we have in American industry? It is questionable whether the Soviets could do that and at the same time do a lot of other things.

Mr. IDDLES. I think that is exactly right, and that is the basis we have been getting ourselves ready for and are now ready to do just that if the roadblocks were removed.

Senator JACKSON. Mr. Chairman, I think that is one area the committee should look into very carefully because the experience that American industry acquires aboard of course will be available to our own people. It is all a part of this program of a diversified approach in the construction of reactors which in the end will, through trial and error, provide us with feasible, low-cost atomic power in the future. It doesn't always have to be in the United States.

Mr. IDDLES. No, we have that tremendous problem of trying to do it economically in the United States, and it is a lesser problem in Europe.

Senator JACKSON. This whole thing resolves itself down to the simple fact that in the United States at this stage of the art atomic power is not economically feasible unless there is a subsidy in one form or another. Is that not a fact?

Mr. IDDLES. I should say there are perhaps as few spots in the United States in which it would be economic right now, but in most of the United States your statement is correct.

Senator JACKSON. There may be some remote mountaintop some place. Can you name an area?

Mr. IDDLES. Maine and Florida are not too far removed from zones where it might be economically feasible shortly.

Mr. LANDIS. I think what we ought to say in answer to that question, Senator Jackson, is that we do not know of a specific area in the United States at present where we could put a reasonably large nuclear powerplant and make it competitive with conventional fuel. However, as Mr. Iddles has pointed out, there are some areas where we are fairly close to being competitive and since we have not surveyed the entire United States there may be some areas where we have missed the boat.

Senator JACKSON. Of course the coal people have improved their technology, too. Some of the steam-fired plants have made remarkable strides in reducing costs, isn't that true?

Mr. IDDLES. Yes, as evidenced by the cost of power to the plant at Portsmouth.

Senator JACKSON. That is what I am referring to, and the TVA steam plant at Johnsonville is an indication of that.

Dr. ZINN. Mr. Chairman, I should like to comment on what Mr. Landis said by pointing out that when he says we are now close to competition in some areas, that is, we are now on paper close to competition. The plant hasn't been built. It hasn't been operated. We really don't know how close to competition you are. This is a great hope of course. The hope is that when you build the plant and run it it will be better than we think.

Senator JACKSON. Stated in simple lay terms, we can say the gas is cheap but the car is expensive at this point. Isn't that right?

Mr. LANDIS. That is correct, but we are close enough——

Senator JACKSON. The fuel is cheap but it costs a lot of money to build the plant. The power cost is spelled out.

Mr. LANDIS. I think there is even some doubt as to the cost of the fuel.

As a matter of fact, in our Consolidated Edison project that is probably the biggest unknown. We have enough confidence in the plant itself to bid a firm price on it, so in that respect we feel we are fairly close to being competitive, but as you say, Dr. Zinn, this is on paper. Although we are spending millions of dollars on the basis of that paper, it has not been operated yet and the fuel costs may not be what we predict them to be. We will get to that.

Dr. ZINN. Presently the fuel is relatively cheap. Indeed, sir, that is really there. The trouble is we haven't been able to realize it. This needs further development and experience to bring the cost of the fuel down. What Mr. Landis says is perfectly true. Any present plant on paper seems to have a high fuel cost. It ought to be low. There is big room for improvement there.

The improvement in the last few years, and again this is on paper, is in getting the plant costs down.

Mr. LANDIS. I might say the gentlemen appearing before the committee have had a lot to do with this. They have shown in their estimates and so on that they can get the plant costs down to where it is no longer many times the equivalent of the coal plant. If we can get similar improvement in fuel cost we are in.

Senator JACKSON. In B. t. u. units produced, comparing the cost of uranium to the equivalent cost of coal and oil, isn't it true that the uranium is much cheaper?

Dr. ZINN. The advantage is all with the uranium. Unfortunately it has to be conditioned to be put in the reactor. After it comes out of the reactor it still carries a charge on it. These charges are still too high.

Senator JACKSON. I mean that is a part of your cost.

Dr. ZINN. Part of your operating costs, part of your fuel costs.

Senator JACKSON. Maybe we are talking about two different things, but it goes to the price of the structure that you are building, the capital investment in the plant. I was distinguishing the fuel from the all capital investment.

Dr. ZINN. The difference is that the fuel cost is a current thing, which recurs every month or few years. The capital cost should be made only every 20 years or something like that. It is the recurring high conditioning costs of the uranium to get it in condition to burn it and processing later on which causes the trouble now.

Chairman ANDERSON. Thank you very much, gentlemen.

Mr. Pickett?

May I state before you start, Mr. Pickett, that the Sylvania Electric Products Co. has sent us a statement which I think is very interesting. They have said among other things:

First, I firmly believe that we risk coming in second or third in the international race for the development of peacetime nuclear power in this country unless concrete steps are taken to accelerate our nuclear power industry.

Again:

Inasmuch as I believe it to be important in international relations to be first in worldwide technology of nuclear powerplants, I believe the Government must provide some encouragement to American industry, at this time, such that the entire pace of reactor construction development will be accelerated.

This is a very interesting statement and letter which will be inserted in the record at this point.

We asked Eugene Zuckert, a former member of the Atomic Energy Commission, for a statement and he has replied by sending us a copy of a speech which he was delivering in Chicago on May 16. It is very much in line with this program and I believe the address might properly be inserted in the record at this point.

(The documents referred to by Chairman Anderson follow:)

SYLVANIA ELECTRIC PRODUCTS INC.,
ATOMIC ENERGY DIVISION,
Bayside, N. Y., May 22, 1956.

Senator CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Washington, D. C.

DEAR SENATOR ANDERSON: I sincerely regret that I am unable to accept your most kind invitation to present my views in person to the Joint Committee on Atomic Energy during the hearings commencing May 23. A prior travel commitment, which will take me many miles from Washington, and which I have found most difficult to change, precludes my appearing in person. However, I do hope that my comments, as expressed in this letter, will be of some value to you and the Joint Committee in your deliberations on the Gore bill.

As you undoubtedly know, Sylvania is pioneering in a phase of the nuclear industry which is inextricably bound up with reactor design and is essential to the growth and operation of a nuclear power industry. It is the objective of Sylvania's activities in the field to provide a leading service to reactor builders and operators in nuclear fuel and reactor core manufacture, and in economical reprocessing of spent fuel elements.

The invitation to present my views to the Joint Committee indicated that the committee is interested in obtaining specific information on the status of private reactor projects. Secondly, the committee desires recommendations as to means of acceleration of the civilian reactor program if greater emphasis is required. I should like to give you my views, from Sylvania's point of view, on both questions.

It was a major intent of the Atomic Energy Act of 1954 to permit private industry to spearhead the growth of nuclear power in this country. The door was opened for private investment in virtually all phases of the nuclear industry in order that a healthy competitive industry could be established in the American tradition. To us the enactment of the Atomic Energy Act of 1954 was a green light to proceed with plans for investment in the necessary privately owned facilities to carry out our phase of the commercial program.

Since we believe any plans for commercial fuel fabrication and reprocessing facilities may play an important part in your evaluation of the growth status

of the nuclear industry as a whole, I should like to inform you of what we are doing and planning, commercially, in this field. Undoubtedly, you are already aware of our 10 years' broad experience in developing and processing nuclear fuels for the Atomic Energy Commission.

First, we have established, at Sylvania, a small, but rapidly growing commercial facility for the processing of nuclear fuels. This is in addition to, and quite separate from, our AEC-sponsored operations. Although this new facility, for the moment, can be considered a pilot plant, it is capable of piloting complete core loadings for many reactors being built in this country and abroad. This commercial pilot facility has been operating since the first of the year, and we believe it to be the first such commercial facility to be in operation in this country.

Now, being a pilot facility, the quantities and variety of fuels processed in this pilot plant are necessarily limited; so we are actively proceeding with plans to build what will be one of the largest and most comprehensive, privately owned, nuclear fuel and special reactor component plants in the country. Several sites in the East are currently being considered as the location for this full-scale production facility, and we hope to break ground sometime this summer. With favorable deliveries on construction materials and plant equipment, we expect this plant to be in operation by the latter part of 1957. Our plans call for a facility which can be rapidly and easily expanded to accommodate an increased number and growing variety of types of nuclear fuels. The output of this plant will be available to industry and Government alike, and we expect to conduct our business on a regular commercial, competitive basis. Needless to say, we expect to spend many millions of dollars on this new facility, in addition to the over $3 million already spent by Sylvania in its atomic-energy program to date.

In addition to our immediate plans for the construction of a nuclear fuel and component manufacturing facility, we have entered into active design, and economic studies, leading ultimately to the construction of a completely privately owned and operated nuclear fuel-reprocessing plant. We believe that the earliest feasible date for such a plant to begin operation is late 1960 or 1961. As such, we have geared our timing to this schedule. In this endeavor we have become associated with a leading engineering firm who has been responsible for the construction and design of many of the existing recovery plants, and together we are moving forward to the objective of a privately owned recovery plant. One of the major problems facing us, considering the timing of such a reprocessing facility, is having a reasonably assured supply of spent fuel elements, so that there will be sufficient volume of material to enable reasonable recovery costs to be achieved. As of the moment, this phase of the study is receiving considerable emphasis. It is our intention to proceed with the construction of such a facility just as soon as our studies indicate there is sufficient volume of fuel for reprocessing in this plant to make it economically attractive for our investment.

With the availability of our fuel fabrication facilities, together with an ultimate commercially owned nuclear fuel reprocessing facility, a vital service will be available to the commercial nuclear power program of this country. Without these services, the industry could not exist or grow. We believe that the actions which we are taking in this field, partially implement, within the Sylvania realm of operations, the intent of Congress in passing the Atomic Energy Act of 1954.

Now, in regard to the second question which has been raised, i. e., recommendations as to means of acceleration of the civilian reactor program, I speak for a company which is interested in supplying a vital service to the nuclear power industry as a whole. We have had an opportunity to assess, across the board, many segments of the nuclear power field. As such, I think that my comments might be meaningful to you. First, I firmly believe that we risk coming in second or third in the international race for the development of peacetime nuclear power unless concrete steps are taken to accelerate our nuclear power industry. We know that there has been no lack of interest or enthusiasm on the part of manufacturing firms and the public utilities in trying to establish nuclear power as an important part of their power-generating capabilities. A large number of firms have set up separate development and manufacturing organizations to produce, competitively, nuclear power generating facilities. Utilities and, as a matter of fact, a surprising number of processing industries, have set up separate organizations aimed, ultimately, at the construction and utilization of nuclear power facilities. However, some roadblocks have appeared to the rapid implementation of industry's plans, some of which were discussed

in my May 11, 1956, letter to you. Another major deterrent at the moment, as I see it, is the lack of sufficient experience in operation of these plants to provide the necessary confidence that a nuclear power facility can be run safely, efficiently, and at low cost.

Inasmuch as I believe it to be important in our international relations to be first in worldwide technology of nuclear powerplants, I believe that the Government must provide some encouragement to American industry, at this time, such that the entire pace of reactor construction and development will be accelerated. There is one point I wish to make clear—I have no doubts that were it not for the international need for us to speed up our atomic energy program, industry working as it has with the requisite Government agencies, could, and would develop a strong nuclear power economy in this country. Because our economic incentive to do so, however, is somewhat less than in most foreign countries where conventional power costs are higher, the rate of growth of our nuclear power industry undoubtedly would not be as fast as the current international pace seems to require. It is because of this additional inducement that I recommend some form of immediate encouragement by the Government.

The bill, recently introduced by Senator Gore, known as S. 2725, would authorize and direct the Atomic Energy Commission to construct six nuclear power facilities designed to demonstrate the practical value of utilization facilities for industrial commercial purposes. It is my interpretation of this provision that the Atomic Energy Commission would foot the bill for six complete nuclear power plants which include, not only the power reactor itself, but the necessary electrical generating facilities.

I believe that the motivation behind this bill is basically sound in that it seeks to accelerate the growth of nuclear power technology in this country. This would be particularly so, if it were stipulated that the reactors built were such as to advance the state of reactor technology. I believe, however, that domestically, the existing AEC power reactor demonstration program already provides the necessary mechanism for such a program.

Since no specific funds were provided in Senator Gore's bill for six nuclear power facilities, I can only guess that the complete construction of the six nuclear powerplants will cost the Government several hundred million dollars. Now, if the Government is willing to invest, as a round figure let's say $200 million for the prime purpose of stimulating the technology of our nuclear power industry in order to maintain a lead position internationally, I very much favor the views recently put forth by Mr. Robert McKinney in his recent speech at the Overseas Press Club. As you will recall, Mr. McKinney suggested that this country join forces with underdeveloped countries needing atomic power now, to establish an international version of the domestic power demonstration program. In this way, not only will we be obtaining the same technical advances as we would by building six complete nuclear powerplants in this country, as Senator Gore has proposed, but in addition, since such countries undoubtedly would be willing to contribute a portion of the cost of such nuclear power facilities a good deal more than jut six reactors can be built for our assumed $200 million. Needless to say, internationally, the nuclear stock of this country would increase immeasurably.

I am in favor of the international demonstration power plan since I am convinced that many countries would be anxious to participate in a program wherein technical and financial help would be received from the United States. Secondly, since such plants undoubtedly would be built and fueled by the American nuclear industry, we will have achieved, not only international recognition, but also a great stimulus to the growth of nuclear technology in this country.

Specifically, my reasons for my recommendation are as follows:

1. With foreign capital added to the available United States funds, more nuclear powerplants can be constructed and evaluated than with the use of the same amount of United States Government money alone.

2. This may open the door for the additional flow of private capital to foreign investments of this type.

3. The experience in constructing and operating these powerplants will be spread across a wider base of our nuclear manufacturing industry.

4. The experience gained in constructing and operating these powerplants will stimulate greater confidence in the operation of reactors for power generation in this country and will provide more knowledge and incentive for the later additional private construction and operation of nuclear powerplants.

5. There is a greater chance of finding a low-cost nuclear powerplant if a greater number and diversity of reactors were built under this program than if just six were built.

6. Our leadership in international nuclear technology would be assured.

7. We would be providing the peoples of many technologically backward countries with an outstanding opportunity to raise their standard of living.

In conclusion, I should like to state that I believe industry is willing and capable of implementing the intent of Congress when it passed the Atomic Energy Act of 1954. To this end, Sylvania is planning major investments in order to provide a complete commercial fuel manufacturing and reprocessing service. I further believe that we can maintain first place in international nuclear power technology best by undertaking immediately a cooperative program with technologically underdeveloped countries, as recommended by Mr. Robert McKinney, and at the same time stimulate a more rapid growth of power-reactor technology.

I very much appreciate your invitation to present my views and hope that I shall be able to be present personally at future deliberations of the Joint Committee whenever you believe I can be of assistance to you.

Respectfully yours,

WALTER E. KINGSTON,
General Manager, Atomic Energy Division.

REMARKS PREPARED BY EUGENE M. ZUCKERT, FOR DELIVERY AT INDUSTRIAL NUCLEAR TECHNOLOGY CONFERENCE, COSPONSORED BY ARMOUR RESEARCH FOUNDATION AND NUCLEONICS MAGAZINE, CHICAGO, ILL., WEDNESDAY, MAY 16, 1956

In acknowledging my appreciation for Mr. Luntz' introduction, I want additionally to express my admiration for the part that Nucleonics, under his editorship, is playing in the development of atomic energy.

The first issue of Nucleonics was published in September 1947. Recently, I had the privilege of inspecting a copy of that edition. The contrast with today's assured format and varied content, mirrors the progress of atomic energy in a particularly striking way. The articles in that first issue were necessarily concerned with only the very fundamentals of isotope techniques, nuclear particle technology, prewar nucleonics literature.

There are highlighted in that interesting first effort two quotations, which signaled a concern upon which Nucleonics has concentrated consistently determined effort, and made so great a contribution. These quotations express the maxim that "diffused" and "widespread and informed" knowledge are basic to progress in atomic energy.

Nucleonics has capably pressed for that diffusion. When I was a member of the Atomic Energy Commission, I was charged with the necessary and difficult responsibility for maintaining the objective of security protection of information. At many points this inherently conflicted with the pressures for telling more. In that capacity and since, I have known how firmly and intelligently—and with a great consciousness of responsibility—the pressure for spreading information has been exerted by Nucleonics. The momentum of atomic energy development will steadily grow and its fruits will be magnified as more information achieves an ever wider circulation. Nucleonics' contribution toward that end, and Mr. Luntz' leadership, are a unique and proud addition to the tradition of our journalism.

The Armour Research Foundation and Nucleonics are performing a service to industry in sponsoring this conference. There are many reasons why this is true, but two appeal to me particularly.

First, I think that there is exemplified here the revolution that is taking place in American industrial research methods. There must be—particularly for the companies that are not giants of industry—an ever greater turning to centralized research organizations and facilities, such as the Armour Research Foundation. The company that wants to stay abreast cannot afford to support under its own roof, all the specialized skills and equipment required to do the technical searching that is becoming a greater task for more and more industries. There must be a willingness by individual companies to engage in more cooperative effort and cooperative support, and to create research instruments of common usefulness such as the Armour Research Foundation reactor. This joining together is vital, not only to the progress of research, but also the preservation of a truly competi-

tive system. The alternative can only be a growing concentration of effective industrial research in fewer hands.

Secondly, I regard this conference on nuclear science in other than power uses, significant because of attention those uses deserve. This meeting reflects so vividly the surge of atomic energy into areas where, just a few years ago, the outlook was believed so modest. For example, it was less than 4 years ago that, as a member of the Atomic Energy Commission, I inquired about the future prospects of radiation in chemistry. I asked a lot of people in atomic energy, many highly expert. The response was almost uniformly cautious, often downright discouraging—and usually for seemingly unimpeachable reasons.

It has taken only a brief interval to prove how wrong they were, and many of you in this room are responsible for that progress. Looking back, it is inconceivable that the brief history of atomic energy could have proved so conclusively to the pessimists that things which had never been tried, could not be done. Now it is clear, of course, that in radiation we have a new mode of energy with a versatility yet untapped: radiation as a catalyst, radiation to effect new chemical reactions, radiation to create new or improved chemical products. Already we see, or can foresee, better plastics, revolutionary techniques of food preservation, and a whole host of other exciting possibilities well known to you. As we search and try more, as more radiation sources become available, and as knowledge disseminates and proliferates, possibilities yet undreamed of will become realities. Even at this early date, we know that the nonpower uses of atomic energy will have a steadily increasing impact upon the revolution of our technology.

It is truly amazing that so much can have taken place in atomic energy in such a brief period of time. Certainly, the world has never seen such a compression of research and development to attain significant new advances.

It must seem strange, therefore, that a major issue emerging today is whether this country is moving fast enough in atomic energy. The question focuses about atomic power, and, indeed, there has been much soul-searching concerning it within recent months.

A majority of the Atomic Energy Commission and the leading spokesmen for industry maintain that the United States program is proceeding at a proper pace. But there are many informed dissenters. Senator Albert Gore, of Tennessee, has proposed a Government reactor program based on the failure of private industry since the passage of the Atomic Energy Act of 1954 to make the necessary degree of progress. As the Senator stated recently:

"However laudable may have been the motives of the proponents of this act, 2 years of its operation offer conclusive evidence that we are simply not getting ahead with the job with proper efficiency and prompt development of atomic power."

Commissioner Murray goes a step further and has proposed that the Government undertake the construction of reactors producing a million kilowatts of electrical power here and overseas by 1960.

What these men have in mind has its principal impact upon the problem of our world leadership in supplying atomic power facilities for the other countries of the world.

The program for the peaceful use of atomic energy was nobly conceived. The President's address to the General Assembly of the United Nations on December 8, 1953, caught the imagination of all mankind. Here certainly was a bold attempt to overcome what was termed "the fearful atomic dilemma." The President's words were inspiring: "The United States pledges before you—and therefore the world— * * * to devote its entire heart and mind to find the way by which the miraculous inventiveness of man shall not be dedicated to his death but consecrated to his life."

The Congress in the Atomic Energy Act of 1954 broke the restrictions, which from the first had surrounded the field of atomic energy, and established the legal framework for a broad program of assistance and cooperation. It did this because it realized the need for leadership in bringing the benefits of this great force to the peoples of the world and the political advantage which would follow United States leadership.

That the world looked to the United States for leadership cannot be denied, nor can the fact that we held ourselves as willing to accept the responsibilities which accompany that leadership.

It would be unfair to say that only little has been accomplished in the period which has followed the President's historic address and the passage of the Atomic

Energy Act of 1954. During that period there was convened the First International Conference on the Peaceful Uses of Atomic Energy, attended by representatives of some 73 nations and, during which, there was a heartening exchange of information on a broad scale. The United States Government has negotiated agreements for cooperation providing for assistance and collaboration and for a supply of reactor fuel with some 30 nations. A 12-nation working level group of the United Nations has agreed upon a draft charter with the creation and organization of an International Atomic Energy Agency. The President has allocated for distribution abroad in support of reactor projects 20,000 kilograms of valuable uranium 235.

Viewed in the light of attitudes and actions of just a few years ago, these accomplishments are indeed encouraging; but it is my heartfelt belief that even so, and considering further the difficulties of putting into operation and administering such a program, our words still outrun our deeds. It is my fear that the indications for the future portend that the responsibilites which we have accepted will exceed our accomplishments. Such can only defeat the high and noble intentions and expectations with which the atoms for peace program was conceived.

What is the difficulty, what has happened, and what is needed?

We have attempted to place the administration of this great program into the pattern of ordinary governmental operations. Any one familiar with the processes of our Government will understand the complexities which this has developed.

As a result, there is lacking a single authoritative responsible governmental unit dedicated to the fulfillment of the aims of the program, without redtape, and without the jurisdictional disputes and governmental infighting which inevitably follows:

The Atomic Energy Commission rightfully has assumed the lead in carrying the program forward, but it does not have that single authority and responsibility which is so essential. It must become involved, and thus the program must become involved, with the Department of State and with the various seemingly related policies and programs of that Department. It must become involved with the International Cooperation Administration, with all of the entanglements, procedures, and inconsistencies which apply generally to our foreign-aid program. As a result, the atoms-for-peace program stands in danger of becoming submerged by other programs.

I submit that the program should, to the utmost possible, stand alone as a simple, ambitious, and determined effort that would have as an immediate objective the construction and operation of power reactors abroad, with a definite near-term timetable as its core. Today the United States Government is not building nor planning to build a single power reactor abroad.

We cannot treat this great effort simply as another phase of technical assistance. As Senator Pastore, of Rhode Island, who occupies a position of real eminence in the field, recently said before the Senate in connection with the proposed International Atomic Energy Agency:

"The only things that will make it work—and the only things that could make it work are the reactors which we are yet to build."

This applies to the whole atoms-for-peace program. Senator Pastore said further:

"The international agreement is not worth the paper it is written on unless we build the reactors which will convert special nuclear material into electricity and power. The whole crux of the international agency idea lies in our ability to get on with the job to build these reactors."

This should be the basic approach—as I have said, simple, specific and determined, carried forth by a clear, unmistakable command decision.

We have in this country on other occasions in history gone forth with great programs thought to be impossible. When we have succeeded, it was done because the program was uncomplicated in its essence, direct and imaginative, because it had a priority understood throughout the Government, and because the organizational machinery to finish the job carried the necessary authority to do so.

Great programs accomplish the seemingly impossible and translate an idea into a reality. It is in the same spirit of single-mindedness and purpose that we should approach the problem of getting power reactors built abroad. Let us not diffuse responsibility, but rather let us give to one unit of our Government full authority to achieve the established objectives. And of crucial importance, let us assign to that task the dollars which will insure it can be done.

Toward this end, I recommend that the Congress give to the Atomic Energy Commission the authority to allocate up to a billion dollars to be made available,

through any means at its command, for the construction, within the next 4 years, of at least 10 power reactors abroad, these to be followed within the following 6 years by another 40 reactors. I emphasize number of reactors rather than large numbers of kilowatts of installed power because in many places of the world, quite small amounts of power would be the proper way to accomplish the objectives of the program.

And let us not complicate the realization of this goal by entangling it in the difficulties of other phases of our foreign policy, or consider this simply as technical or financial assistance in the conventional sense.

We have spent many billions of dollars in developing an atomic weapons program, designed to maintain peace throughout the world. It does not seem to me unreasonable to allocate $1 billion for a program of such importance for the same objective. The ultimate cost of the program will be considerably less. Even in the present uneconomic state of reactor-power technology, project costs could be made partly recoverable. As we learn more, the economic self-sufficiency of the reactors will improve.

It is not my view that power reactors alone should be the sole objectives of the program; but also that we should intensify our efforts in other fields particularly in the matter of training technical personnel and in the humanitarian uses of isotopes. But power reactors abroad should be and can be the dramatic focal point of our effort.

We have spoken in clear tones to the world. Our program for action to implement our words should be as inspiring.

That the program I have suggested raises questions and difficult problem cannot be denied. The decisions that are to be made in carrying it out will make many people unhappy. But the hard fact is that time is slipping by, and we are talking of a wasting asset. Unless we move forward with an aggressive, tangible program, the advantage we seized in 1953 with the boldness of our conceptions will be diminished and, indeed, we may awake to find it gone. All the words that can be said about the importance of atomic energy as a force for survival have been said. God grant us boldness in meeting the challenges of atomic energy, for it may well be that our degree of boldness will determine the fate of life upon this earth.

Chairman ANDERSON. Mr. Pickett, we are very glad to have you back with us for your comments in behalf of the National Coal Association.

STATEMENT OF TOM PICKETT, EXECUTIVE VICE PRESIDENT, NATIONAL COAL ASSOCIATION

Mr. PICKETT. Thank you, Mr. Chairman.

Mr. name is Tom Pickett. I am executive vice president of the National Coal Association with offices in the Southern Building here in Washington.

The National Coal Association is the trade organization of the bituminous coal mineowners and operators whose total production is two-thirds of all the commercially produced bituminous coal in the United States.

The bituminous coal industry is opposed to S. 2725 and similar proposals to adopt a "crash program" approach to the atomic generation of electricity, for the following reasons:

1. There is no current domestic need for the development of a new source of power.

2. The construction of a large number of nuclear power plants with the Government paying all the costs would constitute a partial abandonment of the free-enterprise system and a long stride toward complete socialism.

3. The program called for by this bill would result in the construction of unnecessary plants, duplicating experimental plants, at high cost to the taxpayers, for the production of high-cost power.

4. Beneficial results can best be obtained by orderly research and development of nuclear power possibilities, with proper attention to the hazards affecting the public welfare, and with the least possible encroachment on the private enterprise system.

The coal industry does not oppose the Government's present program for orderly research and development of experimental nuclear powerplants. The industry recognizes the need to continue Government sponsorship of the development of nuclear power through the experimental stages.

On February 15 of this year, I presented to this committee the views of the bituminous-coal industry with respect to the atomic-energy program, and with respect to the report of the McKinney panel. In my statement at that time I quoted the resolution adopted on November 1, 1955, by the board of directors of the National Coal Association, setting forth the policy of the coal industry on atomic energy. I believe that policy statement is so important it warrants repetition here:

Be it resolved by the Directors of the National Coal Association, That the following facts and principles should be considered by the executive branch of the Federal Government, the Members of Congress, the Atomic Energy Commission, and the American people, in determining the role of the Federal Government in the development of atomic energy:

I. In the progression of humanity, in furthering world trade, in advancing the cause of peace and in maintaining the world leadership of the United States, there is a need to continue Government sponsorship of the development of nuclear energy. To this end, the National Coal Association recognizes the need for the Government to support the national laboratories and to carry out the basic as well as applied research in the field of atomic energy.

II. Future development of economically feasible nuclear power is necessary to provide power for underdeveloped areas of the world, to assist nations which have power shortages, and to protect the future of the United States in the power field. The National Coal Association therefore recognizes the need for the Government to continue to power demonstration program to optimize the conditions under which atomic power is generated.

III. The public interest requires that atomic energy be utilized principally in whatever ways or processes it will contribute efficiently to the energy requirements of the United States and the world. The conversion of solid fuels to gas and to liquid fuels through the utilization of atomic energy promises great benefits to the people of the United States. The national laboratory effort should be directed toward minimizing atomic-energy fuel-processing costs, increasing the safety of reactor systems against the public hazards, and developing high temperature materials of constructon to the end that all sources of energy will receive their fair share of the total effort to achieve progress.

IV. The United States is one of the few nations of the world blessed with sufficient reserves of fossil fuels to meet the Nation's power requirements at low cost for centuries to come. In the United States the most economic source of steam-generated electric power in the foreseeable future will be plants fueled by coal, oil, or natural gas. Under the competitive stimulus of our free-enterprise system, the ingenuity of the American people will bring about the most beneficial results that can be obtained from all energy sources, including coal, oil, natural gas, and atomic energy.

V. The public interest demands dissemination of actual cost information with respect to nuclear fuels to the greatest extent compatible with national security. To the extent that Government subsdies are necessary in the development stages of the nuclear program, the public should be informed as to the magnitude thereof. There can be no reliable forecast of the comparative costs of power generation until nuclear fuel costs, and the cost of the safe disposal of radioactive wastes, are established.

VI. The Nation's best interests are not served by unwarranted optimism about the early availability of low-cost nuclear power.

S. 2725 would direct the Atomic Energy Commission to construct six nuclear power facilities, and would declare it to be the intent of the Congress—

> that the full resources of the United States should be made available to advance the art of generation of electric energy from nuclear energy at the maximum possible rate.

For the reasons hereinafter set forth, we believe this "crash program" is entirely unwarranted.

The proponents of an all-out program for nuclear power advance a variety of reasons therefor, including the following:

1. It is required if the United States is to maintain world leadership in the atomic power race.
2. The United States has an urgent domestic need for this additional source of power.
3. The vast expenditure of money and effort will be justified by the quick achievement of cheap power or quicker achievement of it than would result from the present program.
4. Private enterprise is failing to carry its share of the burden in the development of nuclear power. A close scrutiny of the facts will show that none of these reasons is valid. First, the proponents contend that a greatly accelerated program is required if the United States is to maintain world leadership in the atomic power race. They point with alarm to Russia's 5,000-kilowatt reactor, and to England's construction program under which that nation expects to furnish substantial amounts of power from atomic energy.

All the known facts indicate that the United States is now in the lead in the atomic power race and will maintain that lead under the present program. Appearing before this committee on February 29, 1956, Admiral Strauss said:

> I know of no country that has been selling any reactors in the world except ourselves * * * I think we are well in the lead, and we will maintain it aggressively.

In his testimony before this committee last week, Admiral Strauss reiterated with emphasis the same thought, and he emphasized other valid reasons for the Commission's opposition to the program proposed by this bill.

The atomic power race will be decided by quality, not quantity. For instance, if the United States is able to develop and offer for sale reactors which will produce electric power at about 10 mills per kilowatt-hour, we will maintain our lead over a country which offers reactors producing 15-mill power. The total cost of the power produced will determine which reactors will be utilized, and this will not be affected by the number and variety of reactors in operation.

Little is publicly known about the Russian nuclear power program. However, at Geneva it was made clear that the Russian reactor produces power at a cost substantially higher than the cost of conventionally produced power in that country. Since conventionally produced power in the United States is much cheaper than it is in Russia, the margin between Russian nuclear power costs and United States conventional power costs is even greater.

The British speak in hopeful terms of 7-mill power from their nuclear plants, but it is quite obvious that this is an arbitrary and un-

realistic figure which will be reached only by crediting the power operation with heavy payments for the weapons plutonium produced. From the information available to the general public, it appears that authorities on the subject are convinced the British reactors presently being planned and constructed will not compete on a cost basis with the atomic power reactors which are being designed in the United States, much less with conventional power in this country.

World leadership in nuclear power will not be maintained by the construction of a large number of full-scale power installations merely to enlarge the use of atomic energy for power purposes. World leadership will be maintained by exploiting atomic power—

at a rate consistent with sound technological, economic, and public policy considerations—

to quote the language of the AEC.

The second argument advanced is that there is an urgent domestic need for an additional source of power. Time and again the press quotes various spokesmen, including Government officials, to the effect that the world reserves of coal are very limited, and the United States' reserves of coal are being exhausted. These statements convey an impression which is a complete distortion of the truth. There are many nations in the world which do have an acute shortage of coal reserves. In the United States, however, we have abundant coal reserves to furnish low-cost power for centuries to come, even if requirements for power production increase as rapidly as indicated.

The McKinney panel report included official United States Bureau of Mines statistics about the coal reserves of this Nation. According to the United States Bureau of Mines, the United States has nearly a trillion tons of economically recoverable bituminous coal. This is enough to last a thousand years, even if we are called upon to double the current rate of production. Further analysis of the figures supplied by the Bureau of Mines shows that approximately one-fourth of those reserves are "recoverable at or near present costs" (enough to last nearly 500 years at the current rate of production).

Again, the Bureau of Mines figures show nearly 300 billion tons more of those reserves (enough to last an additional 500 years at the current rate of production) could be recovered at from 1¼ to 1½ times present costs. There is, therefore, an ample supply of bituminous coal to furnish the energy demands on our industry not only for the next quarter of a century, but for the next millenium.

In the face of these official Government figures, it is intellectually dishonest to imply that our coal reserves are rapidly vanishing. Centuries from now our coal reserves may begin to reveal a tightening supply, but that hardly implies any "urgency" for the program proposed in this bill.

We not only have the coal—we have the ability to produce it. Unlike the coal industries of many foreign nations, the United States coal industry has achieved, and is continuing, an astounding rate of technological improvement. In 1940 only 35 percent of underground coal production was mechanically loaded, and national productivity averaged slightly over 5 tons per man per day. At the present time more than 82 percent is mechanically loaded and national productivity averages 9 tons per man per day. The Bureau of Mines states that "significant developments are expected in all phases of the coal

economy, including mining, transportation, improvement in present utilization, and in new or expanded uses.

Countries less fortunate than the United States, faced with a power shortage, may be compelled to proceed now with the construction of nuclear powerplants which are far from satisfactory and whose product is of such high cost as to make it an impractical and uneconomic operation if used in the United States. Such a course should not be followed here. England finds itself unable to meet its present power requirements with coal, and is therefore forced to seek another power source immediately. For this reason, the British are unable to pursue the most efficient method of developing economic nuclear power. On October 26, 1955, speaking at the National Industrial Conference Board's 4th Annual Conference on Atomic Energy in Industry, the Right Honorable Lord Citrine, chairman of the Central Electric Authority of Great Britain, said England is faced with a "very acute shortage of coal," which would grow to a shortage of 10 or 11 million tons per year by 1965. Lord Citrine said there was no indication of future improvement of coal output in England. He then stated:

> Now with this as a background, it follows that our approach to the problem of utilizing nuclear power for electrical generation must be somewhat different from those in countries like your own, where you have vast resources, not merely of coal but of water and natural gas.
>
> I think it is important to remember that what might be uneconomic in the United States might prove in Great Britain not only to be economic but absolutely imperative for the industrial life of our country. Britain must push out with the development of nuclear power, and it is with that consideration always before us that we have to view this problem * * *.
>
> The real problem is that there may not be sufficient alternative fuel available and in these circumstances the economic argument moves into a different field. Then the problem can be stated in the following terms: Is it better to scale down our industrial output and living standard to the amount of fuel that is available? Or should we bear the extra costs of nuclear power and, by a corresponding tightening of our belts in other sectors of our economy, maintain our industrial activity and our economic strength?

As previously shown, the United States has no corresponding fuel deficit. For that reason, we are not forced to undertake the inefficient and uneconomic road to the development of nuclear power—indeed, it would be very extravagant of our tax resources to do so.

A third argument advanced by the supporters of the principle of this bill is the expectation that widespread construction of reactors will result in quick achievement of cheap power, or quicker achievement of it than would result from the present program. Competitive nuclear power, like world leadership in the nuclear power race, depends upon quality, not quantity. Construction of a large number of reactors to produce power at costs far in excess of power from conventional fuels is not the most promising road to accomplish the scientific developments necessary before nuclear power can compete with conventional fuels. There is no assurance that nuclear power will ever be as cheap as today's power from conventional fuels. Eventually, with the proper scientific research, utilized in the most efficient manner, the cost of nuclear power might be reduced to a point where it may be of some benefit to the economy after conventional fuels become scarce or greatly increase in price. Whether the crash program approach or the orderly scientific research approach is adopted, there is no indication that the result will be a power cost any lower than

today's power from conventional fuels. Furthermore, the cost of conventionally produced power is expected to drop with improved technology in mining, transportation and utilization.

One of the limiting factors to nuclear power progress is the extreme shortage of qualified personnel. Progress in the nuclear power art should be achieved far quicker by using the available personnel on research and experimental plants, than by using such personnel in the construction and operation of a number of plants which admittedly are going to be unable to contribute to the Nation's energy supplies on an economic basis. The potential of scientific personnel will particularly be wasted where they are used for projects which duplicate other projects.

Passage of S. 2725 would result in uneconomic utilization of scientific personnel by providing for the construction of projects which will duplicate other plants. We submit that no project should be constructed with Government funds or subsidy to produce power at a loss unless it is a new type of facility which is different from any other facility. Government subsidy of one of each basic type of reactor may be justified on the grounds that the knowledge and experience thereby gained advances the nuclear power art. To subsidize a plant which duplicates substantially a plant of the same type is to waste personnel and money. This viewpoint was well stated by AEC Chairman Lewis L. Strauss on November 9, 1955, when he said:

> The information paid for in this manner must, of course, be new information which will supplement existing knowledge, otherwise it cannot be said to contribute to the advancement of the art. This means that the Government, generally speaking, will not invest in projects which appear to duplicate each other. Under this philosophy the Commission could not justify giving financial assistance to research and development work on two or three reactors which are of the same type and size, and which, therefore, could be expected to produce the same or very similar data.

In this connection, it is important to note that S. 2725 provides that—

> The reactor construction program authorized by this act shall be in addition to the reactor development program being carried out by private or public groups under licenses authorized by section 103 of the Atomic Energy Act of 1954.

The Atomic Energy Commission recently stated to this committee that it presently has eight major types of reactors which are currently under consideration. Listed were nine pilot-sized reactors which are under construction by the Government for the purpose of developing civilian atomic power. Listed was one full-scale plant (the pressurized water reactor at Shippingport) under construction by the Government. Listed were 10 reactors which will be built with Government subsidy. In addition, there were three reactors listed which will be built without Government contribution to the capital cost. Already duplication of effort is becoming a probability, because the Shippingport reactor, the Yankee atomic reactor, and the Consolidated Edison reactor will all be of the pressurized water type, even though there is some difference in size.

At the present time is cannot be determined how many of these reactors will eventually be licensed under section 103 of the Atomic Energy Act. However, it seems quite plain that S. 2725 expresses the intent that the six new plants called for would be built in addition

to the present program and in duplication of plants which will be constructed under the present program.

Information available makes it quite obvious that at least one of each type of reactor considered worthwhile will be constructed under the present program, with or without Government contribution to the capital cost. It follows, therefore, that each and every one of the six additional plants which would be constructed under S. 2725 would be a duplication of some other plant and would be an inefficient and wasteful use of personnel and money.

A fourth reason assigned by proponents of this crash program is that private enterprise is failing to carry its share of the load in the nuclear power program. It is quite obvious to us that this charge is incorrect. We have been cited no instance in which the Atomic Energy Commission has failed to receive private enterprise cooperation in any type or size of reactor considered worthwhile. Commission officials have previously testified, in effect, that every type of reactor is proceeding as fast as orderly planning and development will permit.

Private enterprise is contributing a great deal to the nuclear power development program through the construction of experimental plants. Private enterprise should not be expected to waste their own or the Government's money on the construction of plants which will merely increase the consumption of nuclear power but which will not contribute to the nuclear power art because they duplicate other plants and will not produce new knowledge. Neither should the Government itself do so.

A recent publication of the American Enterprise Association, entitled "The Role of Government in Developing Peaceful Uses of Atomic Energy," had this to say:

> If nuclear-produced power is to assume its proper place in the world economy, it must eventually do so on a basis of free and open competition with other power-producing fuels and not by subsidy, international or otherwise * * *.
>
> Shall we absorb atomic industry into the traditional framework of our society? Or shall we use the excuse of atomic age problems to abandon the democratic processes? * * *
>
> If atomic energy is to become a part of our traditional economic and political structure, the next decade will require a continuation of the program begun in 1954–55, thus encouraging atomic energy to be assimilated by the competitive system * * *.
>
> Employing the highly efficient price system in the development of atomic energy is not something which can be accomplished immediately * * *. The sooner a maximum degree of freedom can be given to industry, including the freedom to lose money, the less likely we are to misuse our resources. It may also be the way we can contribute most to the economic advance of the world. In struggling to preserve civilization, freedom is our greatest asset; we ought to exploit it to the full.

The duplicate facilities called for by S. 2725, to produce high-cost electricity at the expense of the taxpayers, would increase the unknown but potentially disastrous, public hazard. There is serious question whether Congress should subject the people of this nation to such dangers even where the plants involved are true research plants which may eventually benefit the public. We very strongly feel that Congress should not impose these hazards upon the people merely for the construction of unnecessary plants, particularly when so little is known as yet about the full disaster potential.

I believe the following statement, which I made before this committee on February 15 of this year, warrants repetition here:

On the basis of the known facts, we believe that in most sections of the United States the most economic source of steam-generated electric power in the foreseeable future will be plants fueled by fossil fuels. We believe that for the foreseeable future the maintenance of a dynamic and expanding economy will depend upon the availability of ever-increasing amounts of low-cost energy from coal. We have the coal reserves necessary to meet the nation's needs. We have the know-how and the manpower to produce that coal. We confidently expect to meet the Nation's expanding energy demands within the framework of the free-enterprise system, without subsidy, and we believe the Nation's dependence upon coal warrants close congressional scrutiny to the end that legislative inequities against the coal industry shall be eliminated. We do not fear inroads upon our market by nuclear power—we believe that for many years to come the atomic energy program will consume far more coal than is displaced by nuclear power.

Thank you for the opportunity to present the views of the coal industry.

Thank you, Mr. Chairman.

Senator JACKSON (presiding). Thank you, Mr. Pickett. We appreciate having your statement.

I merely want to make one comment. I think Senator Gore made it clear that his proposal would not duplicate nor is it the purpose of his proposal to duplicate proposed private or publicly constructed or owned reactor facilities. There may be some misunderstanding, but I think he has made it quite clear that the intent of the proposal is to build new plants of new design so new experience may be obtained. I believe that is true. There may be some misunderstanding about it, but anyway that is what he has indicated.

We do appreciate your coming up and testifying and we always enjoy your appearances before the committee.

Mr. PICKETT. Thank you, sir. May I make one brief comment in response to your statement?

Senator JACKSON. Certainly.

Mr. PICKETT. We do not understand from reading Senator Gore's bill that the result will be as you have stated. I do not disagree with the chairman's statement on the point, but we don't understand it from a reading of the bill. We do say, however, that whether it be true there is a duplication or not, it is not compatible with economy of personnel or money to construct, just for the sake of generating power, unneeded facilities in this country, under the circumstances outlined in the bill.

Senator JACKSON. So far the Atomic Energy program has really helped the coal industry in Hanford and of course in the TVA area.

Mr. PICKETT. We agree that is true and we anticipated as stated in our conclusion it will be true for many years to come. At the same time we just feel that this ought to be an orderly program of development. We have endorsed, as I believe the chairman knows, the present program, not the program embodied in this bill, if I may say.

Senator JACKSON. Thank you ever so much. We appreciate your coming.

The committee will stand in recess until 2 o'clock in this room.

(Whereupon, at 12:30 p. m., the committee was recessed, to reconvene at 2 p. m., the same day.)

AFTERNOON SESSION

Representative PRICE. The committee will be in order.

This is a continuation of the hearing of the joint committee on the legislation to accelerate the civilian reactor program, including Senate bill 2725, introduced by our colleague, Senator Gore.

The first witness this afternoon is Charles H. Weaver, vice president of the Westinghouse Electric Corp.

Mr. Weaver, will you begin your statement, please.

STATEMENT OF CHARLES H. WEAVER, VICE PRESIDENT, WESTINGHOUSE ELECTRIC CORP.

Mr. WEAVER. Thank you, Mr. Chairman.

My name is Charles H. Weaver. I am vice president of the Westinghouse Electric Corp., responsible for that company's atomic power operations.

In appearing before your committee today, I am hopeful that I can be of some assistance in your deliberations aimed at assuring that the United States has an adequate atomic power development program underway.

I intend that this statement shall be a brief one in view of the many considered thoughts which have already been presented since these hearings opened last Wednesday morning.

My primary objective will be to acquaint you with the scope of my company's activities in the nuclear power field and the status of those projects which are directed toward the generation of electricity from nuclear energy.

Westinghouse is a manufacturer of power equipment. This was our motivation to actively enter the reactor development field some 8 years ago.

At that time, the law only permitted us one customer, the Government, and our efforts for 5 years were devoted to the strategic application of nuclear power to a submarine.

With the successful operation of the submarine thermal reactor prototype plant in Idaho in early 1953, all of us were given the first evidence that large amounts of useful power could in reality be produced from the atom.

With that event, our country took first place in the world's atomic power program. I do not believe that we shall ever lose that position of leadership so long as we continue to concentrate on advancing the art through the most profitable use of our resources in technical manpower, industrial know-how and facilities. I vigorously support Admiral Strauss' statement that kilowatts should not be regarded as the measurement of accomplishment.

In 1953, the technology of pressurized water reactors appeared ready to be advanced to plants much larger than those required by a submarine. Not only because of the law as it existed then, but also facing the tremendous risk and obviously large sums of money involved, it was only logical that government should determine to proceed with the 60,000-kilowatt PWR project and contract with Westinghouse to develop the reactor and with the Duquesne Light Co. to supply the turbine-electric portion of the plant and operate the overall plant.

This Shippingport reactor, which will be the world's first full-scale

atomic plant for the generation of electricity has been the responsibility of the Westinghouse Bettis Atomic Power Division working in close partnership with the Atomic Energy Commission and the Duquesne Light Co. Its problems have been no less than I pictured to this committee in July 1953, but progress has nevertheless been good and operation is still scheduled for 1957.

Early in 1952 my company began studying the application of nuclear power to electric generating stations, using Westinghouse facilities and money.

By the time Congress changed the Atomic Energy Act in August 1954, we were ready to work closely with those electric utilities who wished to explore the possibility of atomic power for their systems.

Today our commercial atomic power activities are actively engaged in 2 more of the 7 large prototype powerplant projects which have been identified by the Atomic Energy Commission. One is the homogeneous type plant which we are developing in partnership with the Pennsylvania Power and Light Co.

The other is the pressurized water type plant which the Yankee Atomic Electric Co. will build under the power demonstration reactor program.

The Pennsylvania advanced reactor project is a development effort jointly sponsored by the Pennsylvania Power & Light Co. and the Westinghouse Electric Corp. The overall goal is to design, construct, and place into operation an aqueous homogeneous reactor plant capable of developing approximately 150,000 kilowatts of electrical energy. This plant is to be in operation on the Pennsylvania Power & Light system in 1962.

From the time of its inception in August 1955, to some time early in 1958, the task of the project's scientific and engineering force will be to carry out sufficient development work to establish the technical and economic feasibility of one of the several proposed homogeneous reactor schemes.

The planned second phase of the project, beginning in early 1958, will be devoted to the detailed engineering, design, procurement and construction of the plant itself.

At the present time a total of approximately 60 engineers and scientists, out of a total of about 100 people, are directly engaged in the PAR project, as we call it. The number of technical people will grow to about 80 before the end of 1956.

Included are Pennsylvania Power & Light Co. personnel, as well as engineers of the Union Carbide Nuclear Co. who have accepted responsibility for the reprocessing system.

The work that is currently being carried out in our Westinghouse laboratory in Pittsburgh can be roughly categorized into four areas:

1. We are investigating the physical chemistry of thorium oxide and uranium oxide slurries with particular reference to the effect of different methods of preparation;

2. Looking toward the obtaining of engineering experience in the pumping of suspended fuels through equipment simulating that of a reactor plant, we are constructing a number of relatively large, high-pressure, high temperature circulating loops.

The first of these has been completed, has gone through its preoperational tests and will be loaded with thorium oxide slurries some time this week;

3. We are critically examining the plant systems and maintenance and we are evaluating the associated scientific and engineering problems;

4. We are working with component manufacturers on the development of those large components for the ultimate plant which are expected to be unconventional as compared with present-day powerplant and chemical process practice.

Although the work I have described has been closely linked with the experience gained at the Oak Ridge National Laboratory since 1950, it must be pointed out that our work does not duplicate present developments at Oak Ridge, but supplements and augments this effort by funds from private industry.

It is only through such extended development efforts that we will be able to proceed with confidence into the design and construction of the full-scale homogeneous reactor plant.

The Yankee Atomic Electric Co. 134,000-kilowatt nuclear powerplant was described by Mr. Webster last Friday. With the objective of having a reliable plant in operation in 1960, the pressurized-water type of reactor was chosen.

With the objective of economically competitive power in mind, a new nuclear core design is being undertaken by Westinghouse utilizing stainless steel as the structural material.

Our commercial atomic power activities are now at work on the developmental aspects of this project, cooperating closely with the Stone & Webster Engineering Corp., the architect-engineers. To make confident predictions of operating results at this point would be foolhardy, but the Yankee plant will unquestionably contribute in large measure to improved economic performance of pressurized-water reactors.

We will have approximately 65 engineers and scientists at work on this project in our own facilities by the end of 1956.

The third electricity producing atomic powerplant which is the responsibility of our commercial atomic power activities is the 11,500-kilowatt reactor which is being built by Westinghouse for a syndicate of Belgian customers. The first nuclear powerplant to be ordered by a foreign country under an agreement of cooperation, and scheduled for operation in Brussels in 1958, this project is a very real example of advancement of the atomic power art through the initiative and investment of industry.

Although a pressurized-water reactor, the requirement of low enriched uranium fuel results in a brandnew design reactor core. This means new and costly development, manufacturing and testing facilities on our part and on the part of some of our suppliers.

Over 50 of our engineers and scientists are now at work on this reactor and I can report good progress. All major plant components are on order, the Mallinckrodt Chemical Works are erecting a new plant to convert uranium hexafluoride to uranium oxide, and core design and core fabrication processes are being finalized.

With the entire Belgian project being done on a commercial basis, economic forces have contributed heavily to the reactor design. This can only be healthy for the future of the power reactor business.

Through facilities and development effort associated with the three commercial reactor projects I have mentioned, as well as our Westinghouse testing reactor, our atomic equipment department, and our

atomic fuel department, my company has already committed in excess of $20 million to the reactor development and manufacturing business. We shall continue to invest in the future of atomic power as sound reasons to do so present themselves.

When I appeared before your committee on May 16 relative to the insurance question, I emphasized my strong conviction that technical problems are still our greatest concern in the full development of atomic power. Their solution requires not just money and facilities, but also that very scarce commodity—qualified technical manpower.

Strategic applications of nuclear power require tremendous effort, but are going to pay off in know-how applicable not only to the military, but also to the commercial fields.

Fortunately, we do not have an immediate requirement in the United States for atomic energy as a source of electric power. We are not in short supply of coal and do not expect to be for some years to come.

We are not pressed to build any substantial number of reactor plants in the immediate future simply to satisfy requirements for electricity.

Regardless of immediate need, however, there is no question but that we should progress as rapidly as possible toward establishing atomic power as an economically competitive source of electricity.

I thoroughly agree with the McKinney panel's conclusion that the competitive status of nuclear power cannot be appraised until actual construction and operating experience is in hand.

Toward this end, it seems apparent that just as soon as a promising reactor type is ready for full-scale development, its design and construction should be pushed forward. This is consistent with our actions to date.

Seven full-scale atomic powerplants are now specifically headed toward construction and operation between 1957 and 1962. After operating experience with these, we are going to know a lot more about the competitive outlook for atomic power.

Consider the next 5 to 10 years as a shakedown period. During that period build and operate those plants which will contribute to our technology and from that experience map our future program.

My concern, as you know, is that we face squarely the fact that nuclear powerplants are still far from being "off the shelf" items. These plants and the equipment which comprise them are in an initial development period.

Our current military and commercial atomic power programs already impose a heavy drain on our resources of qualified technical manpower and industrial know-how. We must avoid spreading ourselves so thin that advancement of the art is sacrificed to an expediency which is not consistent with the true needs of our country.

It is my belief that the electric utility companies, working closely with power-equipment manufacturers and the Atomic Energy Commission, will act as a very effective and realistic governor on our industrial atomic power program. Given the maximum encouragement of Government, including a legislative solution to the third-party liability problem, I am confident that responsible members of the industry will not permit the United States to move into any secondary position in the development of commercial nuclear power technology.

When and where Government assistance is needed will continue to be clearly identified as long as we move along as a team.

I thank you.

Senator JACKSON. Thank you, Mr. Weaver.

Congressman Price.

Representative PRICE. Mr. Weaver, you certainly have made a clear statement. I do not know whether you submitted this to the public relations office, but I thought maybe it would have been better on page 7 to refer to this as a development period rather than a "shakedown" period.

Mr. WEAVER. Having been associated from time to time with marine type equipment, I suppose we think of shakedown cruises and refer to anything that we want to try out as being a shakedown.

Representative PRICE. Mr. Weaver, of course, as chairman of the Subcommittee on Research and Development, I have been greatly concerned with the problem of manpower. You are familiar with the committee hearings that have been held on that subject.

I notice that you, as has almost every other witness who has appeared here so far in these hearings, made some reference to that problem.

Your company has been participating in the atomic energy program for a good many years. If you people are not experiencing any problems, I do not know any other company that would be.

I wonder if you could elaborate a little on that problem in that connection.

I notice that you have three commercial projects underway now under the terms of the 1954 act.

Now, what particular manpower problems have you had in setting up those projects? Do you anticipate any progress in those projects?

Mr. WEAVER. I think, Mr. Price, I should start by saying that our greatest recruitment effort in the sence of getting qualified technical people and training them where necessary still rests in the field of our Government development contract responsibilities at Bettis Field.

This has been a very difficult task. We have naturally realized that it was not going to do our country's overall effort any good to simply raid other atomic energy development installations.

We have concentrated on bringing people in from other fields and training them.

The some practice has been followed in a more limited manner with our commercial atomic power activities. We have succeeded reasonably well in bringing in people who could do these immediate jobs on hand.

I concern myself with any substantial expansion beyond what we have now and any plans we have in the future.

Representative PRICE. You say you have three projects now. Do you think it will be possible for you to take on additional projects? If you had a contract to supply a reactor to one of our friends overseas, would you be limited in respect to acting on such a contract because you do have three projects underway now, or would you be in a position to accept that work?

Mr. WEAVER. Naturally the primary question arises as to the amount of technical effort that is in a given project. If a project is a duplicate of a prior one, the technical effort required is a minimum.

If the plant, as distinguished from the core development, the reactor fuel element development, is relatively standard, is not a new reactor

system, then your problem of getting people for reactor core development alone is perhaps the most difficult of the ones we face because there we need our metallurgists, we need our physicists, we need our heat transfer people.

We need the scarcest technical personnel in this area of core development.

Where we are talking about plants, this is not so difficult. The more conventional engineers can be rapidly trained to assume the mechanical and the hydraulic problems associated with the plant, the primary loop of a system such as pressurized water.

Representative PRICE. You train them as the program goes on?

Mr. WEAVER. That is right.

Representative PRICE. There has been a lot of talk, we have heard reference to the pirating of technical manpower. I just do not believe that exists to the extent that may have been inferred in some of the statements that have been heard.

What has been your experience on that? Where do you get the major part of your manpower?

I cannot conceive of Westinghouse going out and stealing personnel from some other companies. Would you comment on that?

Mr. WEAVER. There are two areas that predominate. One, of course, is the colleges and universities, our attempt to bring in young men and train them first of all in the company and its organization, and basic design schools as we call them, and then bring them into our atomic work in the case of those who are interested in such work and train them in the specialties connected with nuclear design.

The other source of technical manpower is among the more experienced people who have been out in industry. Generally we find that there are a number of such people in unrelated production, but not unrelated as far as their technical skills are concerned, who have interest in atomic power.

They are not able to apply that interest where they may be and this draws them to us in response to our recruitment program.

I do think that it is important that there is a certain critical mass, I suppose, in terms of people and development effort that you have going, which in turn will attract further people.

Representative PRICE. How many projects would you say that Westinghouse has in all phases of the atomic energy program? How many reactor projects would you be working on?

Mr. WEAVER. Mr. Price, I don't believe I can speak for the Government projects at Bettis. Those projects have not been completely announced.

Representative PRICE. Five years ago you were probably just about getting into this program. How did you build your manpower staff from that time to this time to take care of each succeeding project that you took over?

Mr. WEAVER. By continually bringing in new people, training them, absorbing them in the organization, splitting them off for new projects as new projects came along.

The growth has been gradual over an 8-year period.

Representative PRICE. Was it a difficult job?

Mr. WEAVER. A very difficult job and very costly job.

Representative PRICE. How would the difficulties of the job today, if you were to further expand, compare with what they were when you started into the program?

Mr. WEAVER. Certainly the availability of technical people, just as such, is a much more difficult problem today than it was 8 years ago.

Representative PRICE. But you are able to train a certain number of people who have no acquaintance at all with this program and probably are trained in mechanical engineering through your plan; is that right?

Mr. WEAVER. Yes, we want the basic know-how that comes with the electrical engineer, or mechanical engineer or metallurgical background, but we do not necessarily require any particular experience in the nuclear field.

Representative PRICE. Do you do any great amount of this on the job training?

Mr. WEAVER. Considerable.

Representative PRICE. How much do you do in relation to the entire nuclear staff?

Understand, I am not cross-examining. This is a very important phase of this whole program. I am trying to get some understanding of the manpower question, whether it poses a continuing obstacle, or whether it is something that you have been able to work out and that other companies might be able to work out the same way as you have done.

Mr. WEAVER. At our Bettis atomic power division we have had constantly not just one, but close to a half dozen different training programs running continually. Such a training program has required a full-time staff responsible for nothing but training.

We are following this same practice, necessarily to a lesser degree because we are not talking the same large needs as yet, with our commercial atomic power activities.

I think, though, that we always have to go back to the source problem in facing up to what is ahead. I was interested in reading today a statement appearing in a report of our Westinghouse educational department which cited the case of one college where they were graduating about 270 engineers this June.

Some 375 companies requested dates to interview those 270 engineers; 35 of these companies were turned away for lack of open calendar dates, just dates when they might come in and interview.

Thirty companies with dates had no student appearing for an interview at all.

On the average each senior received 10 offers or a total of 2,700 offers by 310 companies who interviewed students.

This is evidence of the very fundamental weakness that we have and which we must recognize as we measure our atomic-power-development requirements against all of our other military and nonmilitary requirements for technical personnel.

Representative PRICE. Say Westinghouse were offered a contract by three different nations to build them reactors, or here some half dozen utilities in some different sections of the country would seek to enter into a contract with Westinghouse in the next few years to build reactors for them, would you have to reject those contracts offered because of the lack of manpower, or do you think you would be

able to build, continue the building of your manpower to the point where you would be able to expand with the program?

Mr. WEAVER. Again, it would depend entirely on the developmental content in such contracts. We could proceed with things that we had know-how concerning it. We would be less able to tackle completely new developments and when I say completely new, I don't mean necessarily from scratch, but things we may have worked on across the industry for some time, but which still have many fundamental problems which still have to be solved. That type of contract would be a very demanding one and we would have to stop and think a long time before we can assume very many of those.

Representative PRICE. Now, you have three commercial projects on which you are working at the present time; is that correct?

Mr. WEAVER. That is right.

Representative PRICE. Is it possible to coordinate the activity on each of these three projects with one another, or do you have to have complete separate organizations for each project?

Mr. WEAVER. We have followed the practice in our Bettis Atomic Power Division of setting up a separate project organization for each new major development.

Representative PRICE. Have you found that to be almost necessary?

Mr. WEAVER. We have found that to be necessary insofar as having sufficient management emphasis on that project is concerned.

But that, of course, does not mean that you have to have all your services in each one of the projects. So normally we have a central technical activity which provides laboratory services, computing services, and in general all of the broad and administrative requirements of a laboratory function. That would be centralized.

The development work and the procurement work, structural work specifically related to a given project, would be within a specific project organization.

We have in the case of our commercial atomic-power activities a project group concentrating on the Belgian reactor and a project group concentrating solely on Pennsylvania Power & Light homogeneous reactor. We will have a similar group for the Yankee plant.

Representative PRICE. Do you have a specific requirement annually for young or new blood in your technical and engineering pool that you have to meet in order to keep the organization going.

Mr. WEAVER. I do not have a figure that comes out of any specific consideration of that point, Mr. Price, but I would estimate overall requirements of normal turnover and building for the future would be several hundred young men within our overall atomic-energy work.

Representative PRICE. What has been the history of your success or failure in recruiting that many each year since you have been in this program?

Mr. WEAVER. We have taken on a reasonable number of people from the Westinghouse student course who have been recruited in turn by the company from the colleges and universities.

The rest of the people, younger men, such as you speak of, we have had to go outside and get.

I would say that our experience has been reasonably good, but very tight and very difficult.

Representative PRICE. Mr. Chairman, that is all I have.

Dr. ZINN. As to the subject that Mr. Price was touching on, I am familiar with the fact that your program has grown very much in the last 5 or 6 or 7 years and that your technical staff has snowballed during that same period of time.

Do you think that other companies, had they had the work 5 or 6 or 7 years ago, could have developed similar staffs in this period of time? It is a little bit of a chicken and egg question I am asking.

There are other companies who did not have contracts to develop reactors as you have. They now do not have any staffs. If they had had contracts do you think they would have developed staffs?

Mr. WEAVER. There have been several large projects, of course, which have come along in parallel with our own, and I believe they have recruited numbers comparable to ours. Now, as to how much you can multiply this and still get what you want, I don't know. I think it is a serious question that this committee has faced. We must be alert that Government itself does not impose too great an obligation without knowing its overall effects.

Dr. ZINN. Having in mind one of the purposes of the bill that is before this committee, I would want your opinion if through this bill other large projects were to be generated, would it be possible for companies not now deeply involved in this to accumulate staff in a manner similar to what you did?

Do you think that is a possibility?

Mr. WEAVER. I can only emphasize that I think this requires a very substantial organization, a basic company, to start with.

And the competence of the people who are in charge will determine to a great extent the company's ability to recruit. I do not think there is any yes or no answer to it. I think people can continue to be recruited in this business. Their training and their absorption, in addition to their recruitment, are time-consuming elements.

Dr. ZINN. The main reason I think you identified in answer to Congressman Price's question is that you got started and the nucleus of starting people then grew.

Mr. WEAVER. That is right.

Dr. ZINN. Through your on-the-job training and so on. So perhaps the key to the thing is to get the thing started.

The question is, How do you do this? Perhaps it is to get a contract. That is the way your company started; is it not?

Mr. WEAVER. That is correct.

Senator JACKSON. Following that same point, I just wonder if there is not an opportunity for private industry to improve its techniques in building up the know-how in this field. I wonder whether most of them are pursuing the best course of action that should be pursued in building up personnel, the training program, and so on.

Apparently your company has done very well. The limited resources we have available, the technical resources, are such that it might be well to see what can be done on the part of industry to improve their methods.

Don't you think there is an area in which we can better utilize the know-how that we can draw from and work out a lot of these things that you have mentioned, on-the-job training programs, and so on, that result in a better utilization of the limited technical resources that we have?

Mr. WEAVER. I think that is definitely so. I think that we have to be very careful that we are using technically trained people in the proper positions and that we are using technicians and nontechnically trained people wherever we possibly can.

We certainly must conserve that scarce item.

Senator JACKSON. Yes, people can come before the committee and say, "We can't do this job," but query whether it is true, it may be possible that some of them are not utilizing the best methods and making the best possible use of the resources, the technical resources, that can be made available to them.

Mr. WEAVER. I think we have to be very careful, too, of the fact that you just can't accumulate around you all the good people. There is a limited number of really good first-class technical people and the more people not quite of that caliber that you bring in and try to train and absorb, the more you are diluting those good people.

This provides another serious difficulty in a case like ours.

Dr. ZINN. The question I have in mind is one on which I would like Mr. Weaver to think of the country's program rather than just the reactor-development program of his company.

I think I am correct in stating that your company now is pursuing almost exclusively the aqueous homogeneous and water-cooled approach. Is that correct?

Mr. WEAVER. Those projects on which we are actively working in the direction of actually building a plant are in those two categories.

I would like to emphasize, however, that we have a considerable interest in all of those types which loom particularly as good potentials for economically competitive power in later years, and our participation in the fast breeder project with the Power Reactor Development Co. is just one example of that broader interest.

Dr. ZINN. My question really is this: Do you think that it would be a wise thing for the company to make sure that it has adequate coverage of those reactor types which permit high-temperature generation of steam and high-pressure steam which the water-cooled reactors just can't do?

Do you believe there is some advantage perahps ultimately in thinking of the high-temperature approaches even though your company is not actively now working on those?

Mr. WEAVER. Again, I believe our participation in the Detroit project emphasizes such an interest.

I would like to be careful to state that interest is one thing; the construction of a full-scale plant is another thing.

I think that we must be interested and that we must support the development work that is necessary to determine feasibility. Only then, after feasibility has been demonstrated, should we proceed with a full-scale plant.

Dr. ZINN. Well, of course, I could ask this question: What was the previous feasibility which had been demonstrated before you entered the design and construction of the full-scale submarine plant?

Mr. WEAVER. That was the first. I think we have learned an awful lot since that time, all of us.

Dr. ZINN. But you know that necessity made you go ahead with what was a full-scale plant without looking for a pilot?

Mr. WEAVER. That is a strategic application. I have carefully distinguished between a strategic application and what we must do

there and what we are continuing to do there and what we might require for the production of electricity in this country.

Dr. ZINN. Then, for those people who, in their judgment, think the generation of electricity on a fairly large scale also has its strategic side to it at the present time, they might be justified in thinking that one could move into larger scale construction without all of the preliminary steps, I mean in their view of the thing. Would you agree to that?

Mr. WEAVER. Yes, if there is a strategic side. I have not touched upon any strategic side and I have spoken up to this time purely from the standpoint of normal need for energy in this country.

Senator JACKSON. Senator Knowland.

Senator KNOWLAND. No question, Mr. Chairman.

Senator JACKSON. I have just one question, Mr. Weaver.

With reference to the foreign program, do you not feel that there is a great opportunity in this area to give American industry an opportunity to participate in that tremendous market, especially when you consider that in many parts of the world atomic power could be economically feasible power due to the lack of conventional fuels or hydropower, whereas in the United States we still are up against the fact that atomic power is not economically feasible or economically competitive with conventional hydropower at this time.

Mr. WEAVER. We have certainly found a considerable interest among our foreign friends in atomic energy, as have you.

The extent of the market as such is very uncertain insofar as I am concerned. I think that eventually we will find the same situation prevailing as prevails today on more conventional heavy power equipment.

Where this country can advance development and be ahead of foreign countries the manufacturers of this equipment will sell equipment. When the countries who are interested in using this equipment build their own industries, then, of course, that market will shrink rapidly.

Senator JACKSON. Is your company working on the implementation of the President's program of making U–235 available on a followup basis for participation in the reactor-plant construction program?

A lot of people are going to be asking, "There is a tremendous amount of U–235 that is being available. What happened to it?"

I take it as it stands now, it is a matter of your dealing with various countries, assuming that agreements are worked out and so on.

But I am wondering what your company is doing and what industry in general is doing for them.

Mr. WEAVER. Today there is one country, of course, besides England and Canada, and that is Belgium, who can actually buy a plant and we expect to have a plant in operation in Belgium in 1958.

Senator JACKSON. Has your company made a survey around the world to indicate whether or not the governmental assistance may be necessary to help these countries get started?

Mr. WEAVER. I would say that from our talks, and I have not actively participated personally since last summer, but I would say from the conversations that our international company people have had abroad, the matter of assistance, financial assistance, has not loomed

nearly as important as the straightening out of the internal problems within the country, such as Italy. Some people want plants there, but they don't know whether they want atomic power monopoly or not, within that country.

They must decide whether government is to own their plants or whether private industry may purchase plants before that market is going to materialize.

Of course, after they make that decision, they must enter into an agreement of cooperation with this government. This type of problem seems to be a more prevalent one to be encountered than the financial one of assistance from this country to finance such a plant.

Senator JACKSON. How about underdeveloped countries? Forget about Europe, which has an industrial background. How about the underdeveloped nations?

Mr. WEAVER. We have had no conversations with any of these people. I think unquestionably for plants to go in those areas they probably would have to be supported by the country that is going to supply them. To what extent, I don't know, sir.

Senator JACKSON. It does seem to me to be very important that American industry get together with some kind of concrete approach on this, or we are going to be looking a bit silly after a while because here is an offer made for the fuel, but what is being done to marshal the industrial resources of America to make it possible to build these plants and make this program a reality.

I mean people will wonder what is going on. I am not being critical of industry. Maybe the Government can do something to bring American industry together so that we will have a program that will be moving along so that there will be some real concrete evidence of the announcement that was made by the President making this fuel available. Do you not think that is necessary?

Mr. WEAVER. I think this is right. My statement has looked at the problem primarily, as I said before, as a domestic one.

Now, when we bring in the international aspects, particularly the extent to which this country should go in supporting the development of atomic power abroad, I believe that is an entirely different question and we have to answer that question and if it is desirable that we should as a country give support to atomic powerplants abroad, then I think you will find industry will come along and do its part just as we have tried to do our part in the development of the strategic applications for this country and in the development of this country's industry requirements.

Senator KNOWLAND. So far as I know, Mr. Chairman, the President has not proposed that we permanently subsidize the power industry abroad, either conventional or atomic.

I think that would be quite a far-reaching program beyond the scope of anything which has been suggested. I would be very loath to see this Government undertake a permanent subsidy of power development abroad.

Senator JACKSON. I was just thinking of course, we have in the last few years spent about $50 billion in foreign aid. I do not know whether it is a subsidy or what.

Anyway, it is gone. We have made this announcement, Senator Knowland, that the fuel is available and I think if our program is going to be effected that there at least should be some kind of coordi-

nation with American industry to get the show on the road. I do sincerely believe that it could be very effective, especially in Asia and Africa, not only to take care of energy that is needed in some of the sections of those two continents, but it could have devastating effect on the Russian lies that are being told constantly that the Americans only want to use the atom to kill people.

It could be a double-edged sword, so to speak, the sword and the plowshare.

Senator KNOWLAND. I think that was made perfectly clear in the President's statement that there would be fuel available and the benefits of our research in this field.

But I do not think that that in itself necessarily indicates that it either is or should be sound public policy for this country to embark upon the building in all of the countries of Europe, or Asia, or a substantial number of them, electric power industry, either by conventional means or atomic means.

At least, that is a far-reaching policy. The Senator has mentioned the $50 billion which we have spent. That was for the rehabilitation primarily of a war-torn Europe and Asia and building of a collective defensive system so that they at least would not lose from the possible threat of Russia.

But this to which some mention has been made here today would be more or less of a permanent program of a far-reaching nature which I think certainly the Congress would want to scrutinize very carefully before we embark on it.

Senator JACKSON. I agree, but, of course, we have already spent millions and millions of dollars in loans and in grants for power. We already take great pride in—I believe I am correct in this—a large project in India on which we have made grant and loans, power projects. I do not know whether Westinghouse sold the geenrators or not, but that has been going on for a long time and our own Government has been giving active consideration to the power project in Egypt through the International Bank.

I do not know the exact status of that now. I think it is involved in politics.

But my own thought, Senator Knowland, was that many people throughout the world will wonder what is being done about the fuel that our Government has offered to the world, to the free part of the world anyway.

My suggestion was that there ought to be some kind of coordination in some direction, not with a desire that we are going to give this away, but if we are going to provide, as we have over the years and we have a bill before us, technical aid to the point 4 program and economic assistance, I want to know why this program should be immediately ruled out when we are continuing to render aid and assistance to the countries abroad and we have a request, as we all know, from the administration, which I think is a sound one, that there ought to be some long-term foreign aid commitment. I have always supported the foreign-aid program.

Senator KNOWLAND. I have supported the foreign-aid program too, but not as a permanent program.

Senator JACKSON. Not as a permanent program, but we are all finding this is turning out to be permanent in that we have it every year with us.

I hope it will come to an end one of these days, but that is a long-range problem.

Mr. WEAVER. Senator Jackson, I would like to say that if it should be Government policy to step out even a bit faster than we are in helping foreign countries, we must be very careful that we are both ready to render that help in the sense of knowing our own technology and having proven it out in this country as well as knowing that the country to which we will supply the plant is ready to receive that plant.

I think that that country has to be equipped with people and some basic technology which will permit their getting from the plant what we intend.

Senator JACKSON. That is right, but when I opened up this area of questioning, I was wondering just how this was being handled at the present time, whether industry was pushing the program and attempting to interest some of these countries where nuclear power would be economically feasible.

Mr. WEAVER. I suppose that that is best evidenced by the action that was announced last week by the American and foreign power people where they have actually committed themselves, as I understand it, to supplying some plants without having specific countries in mind.

That certainly is a direct action of the type you speak of.

Senator JACKSON. If we are going to build atomic powerplants abroad, it is obvious that some of these countries do not even have the know-how to operate these plants after you build them.

Mr. WEAVER. That is right.

Senator JACKSON. More than that, there is hardly a country, at least there is probably none in Asia or Africa, that could build its own atomic powerplant.

Now, if they are going to get atomic powerplants, then it does seem to me that American industry has a great opportunity to participate in the development of that undertaking which will inure not only to the benefit of the people in those countries, but it is conceivable that it can inure to the benefit of American industry and to the people of this country; is that not correct?

Mr. WEAVER. Yes, but I think the Government must set the pace and American industry will do its part.

Senator JACKSON. The way it is now I just do not understand how private industry would know what to do.

Mr. WEAVER. Today all that we can do is talk to those people who might get agreements of cooperation with this country under our law in the future and who would be financially able and have the desire to operate a nuclear powerplant.

Senator JACKSON. Do you not feel this is one area where America with its present industrial advantage over the Soviet Union could take leadership in making the peaceful atom available to a lot of people that do not have it now?

Mr. WEAVER. I believe that we have more technology to offer than anyone else in the world today.

Senator JACKSON. Yes, but the Russians conceivably, if they want to abandon other projects, could move into this area as a part of their formal policy. If they do, they would have to in all probability abandon some other activities. But we have a broad industrial base,

we can pursue a greater number of undertakings at any one time than the Soviets can. You would say that in general, would you not?

Mr. WEAVER. Yes, I think that has been evidenced.

Senator JACKSON. So this is an area where it does seem to me that American industry cannot only provide assistance to these countries in making available technical know-how and the resources of American industry, but we can also maybe help our foreign policy. It will be a type of program that will leave some concrete evidence of results compared with some of the foreign-aid programs that we have participated in.

Mr. WEAVER. That is a matter again that I think I must refer to the Government for policy and direction.

Senator JACKSON. Are there any further questions?

Thank you very much, Mr. Weaver.

Mr. WEAVER. Thank you, Mr. Chairman.

Representative PRICE. The next witness will be Mr. T. G. LeClair, engineering assistant to the vice president of Commonwealth Edison Co.

STATEMENT OF T. G. LeCLAIR, ENGINEERING ASSISTANT TO THE VICE PRESIDENT, COMMONWEALTH EDISON CO.

Mr. LECLAIR. Congressman Price, members of the Joint Committee, we are grateful for your invitation to appear again before your committee to discuss the experience of the Commonwealth Edison Co. in the field of nuclear power.

Mr. Willis Gale, chairman of our company, appeared before your committee on two occasions this year. In his two statements he traced our participation in the development of nuclear power from the date of our study agreement with the Atomic Energy Commission in May 1951 to the current status of our project. He told you that:

1. Out of these studies came our proposal to AEC in March 1955 to build a full scale nuclear powerplant 50 miles southwest of Chicago.

2. It will be a boiling-water reactor.

3. General Electric Co. will build the plant for $45 million.

4. Fifteen million dollars, one-third of the contract price, will be paid as a research and development expense, by Nuclear Power Group, Inc., composed of American Gas & Electric Service Corp., Bechtel Corp., Central Illinois Light Co., Illinois Power Co., Kansas City Power & Light Co., Pacific Gas & Electric Co., Union Electric Co., and our own company, Commonwealth Edison. The remainder, $30 million, plus site and overheads, will be paid and capitalized by Commonwealth Edison.

5. With an early settlement of the insurance problem, the subject of your recent hearings, we expect our plant to be ready for trial operation by July 1, 1960, 6 months ahead of the contract schedule, and 3 months ahead of the deadline set forth in AEC's construction permit and fuel allocation granted us May 4 this year.

6. To date, we and our associates have paid General Electric a total of $3,750,000, and by the end of this year will have paid $9 million. Monthly payments of $750,000 will continue for 5 years until the entire $45 million is paid.

7. We feel we are serving not only our industry's interest, but, more important, the national interest. In addition to Mr. Gale's reference

to our project, Mr. Philip Sporn, president of Nuclear Power Group, Inc., and Mr. Francis McCune of General Electric Co., have also testified on different phases of our project.

Now let us look at the nature of the project and the progress which has been made. The net electrical output will be 180,000 kilowatts. This is larger than the average coal-fired unit being constructed by public and private utilities in this country today.

It will use a dual-cycle boiling-water reactor, as described to you previously by Mr. McCune. It will operate at a steam pressure of 1,000 pounds per square inch and will produce steam both in the reactor and from external heat exchangers to operate the steam turbine.

Figure 1 (p. 370), which is attached to the copy of this testimony, shows the location of the site in relation to the cities of Chicago and Joliet, and to the high voltage transmission system.

The plant will deliver its power to existing 138 kilovolt transmission lines. It will be known as Dresden nuclear power station.

Figure 2 (p. 371) is an aerial photo of the 950-acre site showing the approximate location of the plant on the property. The site is large enough and water supply is adequate for an ultimate generating capacity of at least 1,500,000 kilowatts, either coal fired or nuclear.

Figure 3 (p. 372) shows how the completed plant can be expected to look. The reactor and all of its auxiliaries will be contained within a large steel sphere. This sphere will be large enough and strong enough to contain all the vaporized products which might result from the most severe reactor incident. Such an incident could only occur if all of the powerplant controls should fail in addition to the simultaneous occurrence of other unusual conditions.

The water tower in the foreground contains emergency cooling water and the stack in the background is for ventilation. The turbine generator will be in the adjoining building at the left.

Figure 4 (p. 373) is a cross section of the reactor and turbine-generator buildings. The various components of the reactor plant are contained in heavy concrete shielding. Inside the sphere is shown the pressure vessel containing the reactor core.

Fuel unloaded from the top of the reactor is transferred to the building at the right. The turbine generator is in the rectangular building at the left. The generator and the remainder of the equipment in the plant is similar to that of a conventional power station.

This powerplant will be operated and have its loading schedule in the same manner as all the other powerplants now supplying capacity to our interconnected system. This is an essential objective since the overall practicality of reactor plants for power generation will only be determined when they are utilized regularly to meet the daily load demands of a power system.

As Mr. McCune has told you, many of the component parts of this project are now being designed, built, and tested either in the new General Electric plants at San Jose and Vallecitos, Calif., or under contracts with other companies.

The design of the Dresden buildings and preparation for construction are proceeding at full speed and on schedule.

So much for what we have said and what has happened.

Now, let me review what remains to be done:

1. AEC must grant an operating license for the plant. The construction permit, already issued, by its terms states that when the

hazards evaluation report, giving the final details of the design, has been completed and approved by AEC, an operating license will be granted.

2. The Illinois Commerce Commission must issue a certificate of convenience and necessity for the project. We expect this certificate will be forthcoming in due course.

3. A satisfactory solution of the third-party liability problem is still to be obtained. As Mr. Gale stated, Commonwealth Edison Co. and its associates, together with General Electric Co., are going ahead in the expectation that this will be accomplished.

The chairman of this committee has expressed the concern of this committee as to whether or not this country is maintaining and can maintain its leadership in the industrial and other peaceful applications of atomic energy.

We share this concern, and trust we can convince you that there has been, or will be, no slackening of effort on our part to push our project to completion.

From the earliest date in 1951, we have assigned our best scientific and engineering talent to the task. There has been no lost time. Whatever time has been consumed has not been due to negligence in maintaining a tight schedule, but rather to the very nature of this development.

In the new and highly technical field of nuclear power, with its unusual demands for safety, security, and regulation, progress is necessarily slower than it would be in the case of a conventional plant. We estimate the added time for this pioneering project to be about 2 years. We suggest this is a good record for establishing a new private industry after the passage of the Atomic Energy Act of 1954.

As I said, the Dresden project is proceeding at full speed and on schedule.

You have heard what GE is doing toward building components. Their subcontractor, Bechtel Corp., is preparing the working drawings for the buildings which will house the project. Groundbreaking at the Dresden site is scheduled for early in 1957. The erection of the spherical containment building should begin in the middle of 1957 and equipment erection in the spring of 1958.

From this point on, construction should move at the same speed as construction for a coal-fired plant. It is expected to go into preliminary operation by July 1960.

What will this project accomplish?

The manufacturers will have developed the equipment, designs, and factories, facilities which will enable additional nuclear powerplants to be built on a much faster schedule. Not the only General Electric and Commonwealth Edison, but all of the partners in NPG, Inc., are following this project in detail. The engineers of all these companies will have obtained the know-how for the overall design and construction of nuclear powerplants.

By the time the plant goes into operation, Commonwealth will have a team of over 100 company men trained to operate it. In addition, the other NPG companies will have taken advatage of the contract privilege to train their personnel in this plant.

This single advanced design nuclear power project will provide the training ground for power companies owning one-seventh of the generating capacity in the country.

In summary, the Dresden project is moving rapidly. It and the other projects now underway should contribute much toward an adequate know-how on nuclear power in the hands of industry. This know-how in our opinion is the Nation's vital need.

We are confident that private industry has been alert to this need, and we have been impressed with the contribution your committee has made to create an awareness of its importance.

We believe that the Nation's best interest will be served by assigning the task of developing nuclear power to private industry. We are confident that private industry is capable and willing to do its part to keep this Nation ahead in this field, as it has in every other area of industrial development.

(The four attachments referred to follow:)

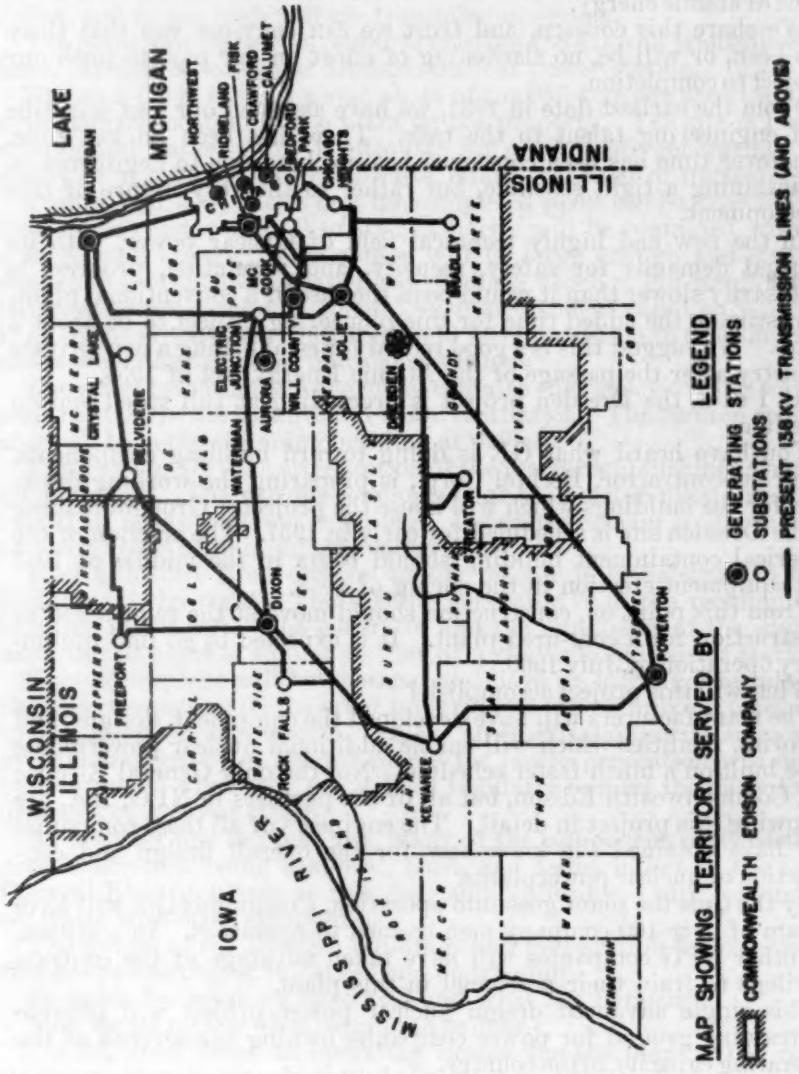

FIGURE 1.—Geographic location of Dresden Nuclear Power Station.

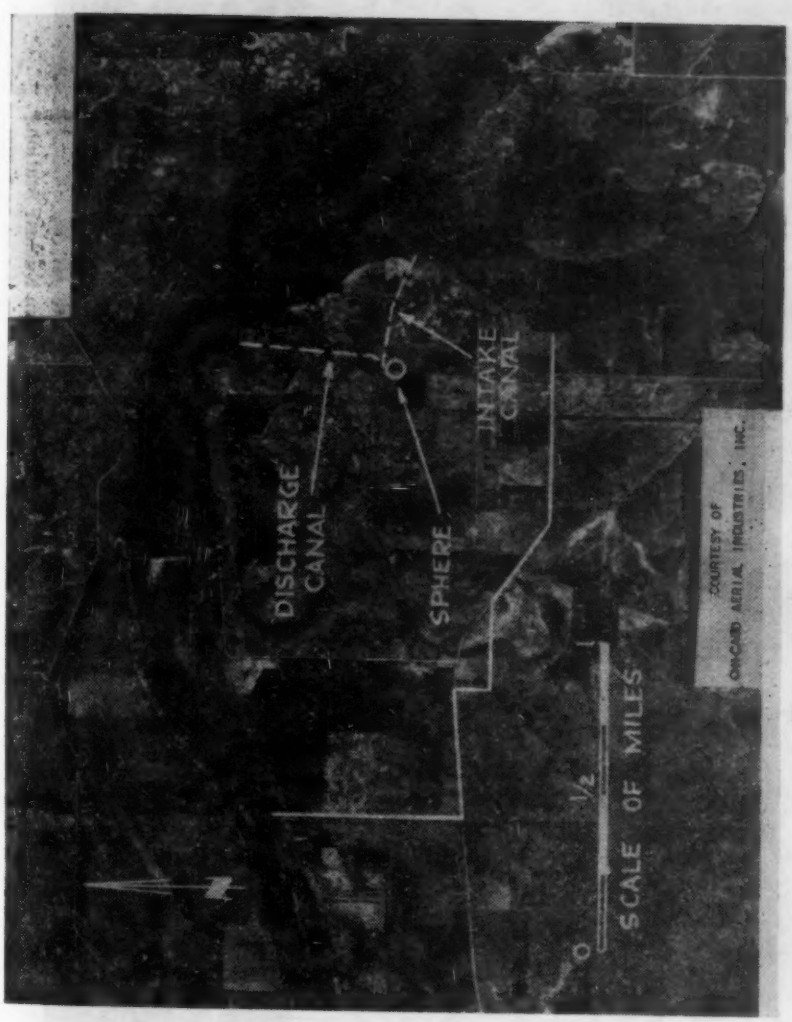

FIGURE 2.—Aerial view of Dresden site.

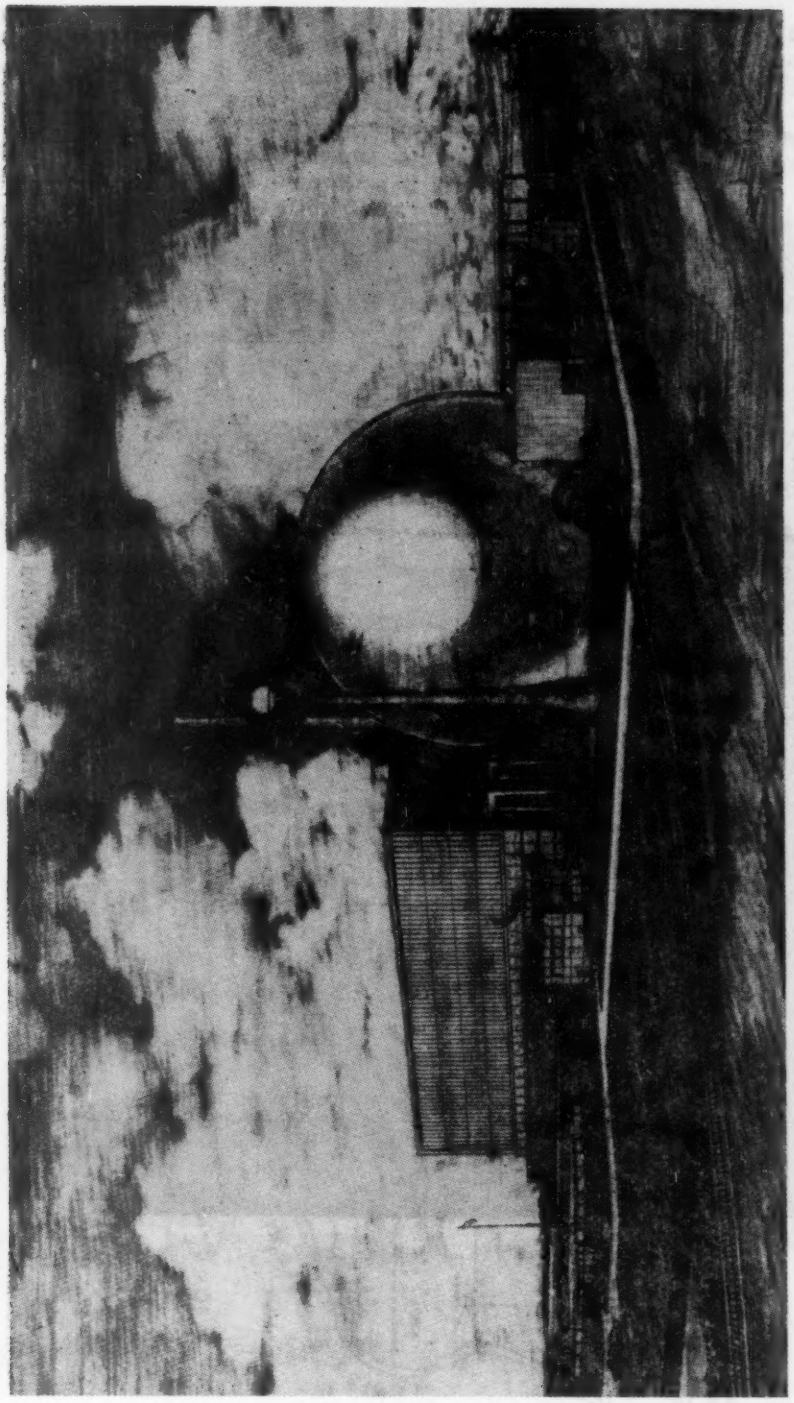

FIGURE 3.—Artist's concept of 180,000 kilowatt Dresden Nuclear Station.

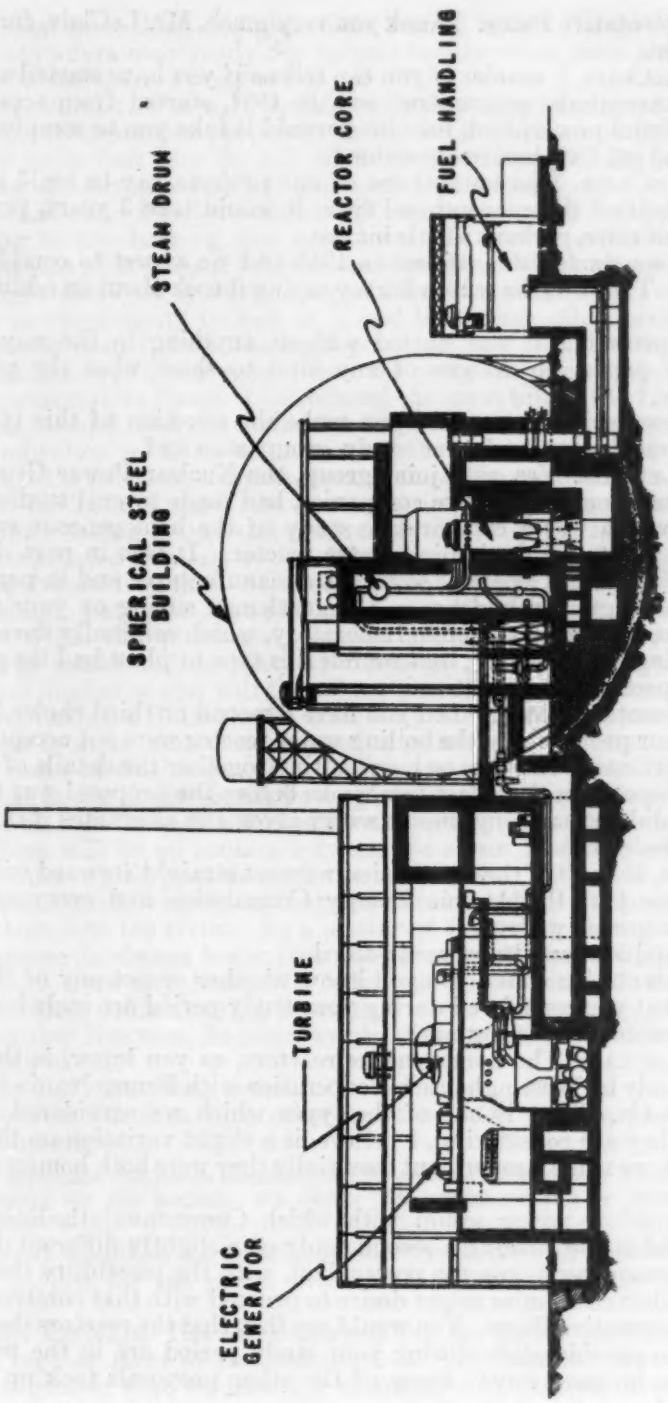

FIGURE 4.—Cut-away view showing major components of Dresden Station.

Representative PRICE. Thank you very much, Mr. LeClair, for your statement.

Mr. LECLAIR, I wonder if you can tell us if you have started a plan for a conventional powerplant, say, in 1954, started from scratch a conventional powerplant, how long would it take you to complete the plant and get the plant in operation?

Mr. LECLAIR. In a normal one of our projects, say to build a new powerplant of the conventional type, it would take 3 years, perahps a little bit more, perhaps a little bit less.

Now, we started this project in 1955 and we expect to complete it in 1960. That was the reason for my saying it took about an additional 2 years.

This project also was started without anything in the way of a piece of paper, no designs of any kind to show what the project would be.

Representative PRICE. Did you make the selection of this type of reactor on the basis of your study group activity?

Mr. LECLAIR. Yes, as a joint group, the Nuclear Power Group at that time, consisting of five companies, had made several studies, the last of which was a comparative study of the homogeneous reactor type of plant and the boiling water reactor. It was in part due to our confidence in General Electric as a manufacturer and in part due to our very great confidence in the gentleman sitting on your right, Dr. Zinn, as head of Argonne Laboratory, which originally developed the boiling water reactor, that we felt this type of plant had the greatest prospects for early economic power.

Representative PRICE. Did you have a second or third choice in the event your proposals on the boiling water reactor were not acceptable?

Mr. LECLAIR. We were so busy getting together the details of making a proposal in those last few weeks before the proposal was made, that we did not have any time to worry about any alternates if this one were not acceptable.

Again, as in all of these activities, we went straight forward with the confidence that the Atomic Energy Commission and everyone else would cooperate with us.

As usual our confidence was justified.

Representative PRICE. Do you know whether or not any of the reactors that you considered during your study period are included now in this reactor study program?

Mr. LECLAIR. The homogeneous reactors, as you know, is the one under study by Westinghouse in cooperation with Pennsylvania Power & Light Co. That is one of the types which we considered. The design they are considering, I believe, is a slight variation on the one on which we made a report, but essentially they were both homogeneous reactors.

The nuclear power group with which Commonwelath Edison is associated is now making a second study on a slightly different design of the homogeneous reactor powerplant, with the possibility that one of the other companies might desire to proceed with that construction.

Representative PRICE. You would say then that the reactors that you took into consideration during your study period are in the present program in some way? Some of the other proposals took up those projects?

Mr. LeCLAIR. That is right. Our feeling is that the projects that were anywhere near ready for current construction have been taken care of in the present program.

Representative PRICE. You referred to a matter of mutual interest, which is the insurance proposal. I wonder if you have had an opportunity yet to look over the bill which was introduced in the Senate by Senator Anderson in an effort to meet that problem?

Mr. LeCLAIR. I had the opportunity to see a copy of that just before coming to the hearing this afternoon, Mr. Price, and the surface appearance of it seemed to me to be something which was pointed in the right direction to solve this problem. I would rather, of course, have an opportunity to look at it and have some other people more competent than I, from the legal point, to look at it, but the surface indications were that it should meet the problem quite satisfactorily.

Representative PRICE. I introduced the same bill in the House, and we are hopeful that the committee can move on this problem because the indication seems to be unanimous that insurance remains an obstacle to the program and that obstacle should be removed.

Mr. LeCLAIR. I think the committee is to be congratulated in so promptly taking action and preparing bills after the hearings which were concluded only last week. We think that is a real forward step.

Representative PRICE. Senator Bricker?

Senator BRICKER. Just two questions, Mr. LeClair. I notice on figure 2 that the sphere and the plant are about half a mile from the place of intake and the place of discharge. What will be the nature of that discharge and will there be any radioactive substance in it?

Mr. LeCLAIR. I think the scale may not be quite accurate. The sphere is more than a quarter of a mile from the point of intake and point of discharge. The cooling water taken in will be similar to that in the conventional powerplant in that it will come from the river and go through a condenser and out to the river again.

There will be no contact between the steam from the reactor and the water which goes through the condenser. There will always be adequate monitoring to see that there are no radioactive products that can leak into the river. As a matter of fact, the pressure inside the condenser is always lower than the pressure of the cooling water, so if there were any leakage it would be to contaminate the reactor rather than contaminating the river.

Senator BRICKER. In other words, there would be no radiation possibility at all?

Mr. LeCLAIR. That is true.

Senator BRICKER. One other question. On page 4, you note the various steps.

The Illinois Commerce Commission must issue a certificate of convenience and necessity for the project. We expect this certificate will be forthcoming in due course.

What would be the arrangements in regard to the rates that would be charged for the power produced? How would they be worked out?

Mr. LeCLAIR. The rates charged for the power produced will be the regular rates of the company. It just happens that under the arrangement that we have for financing this project, turning to the testimony on the first page, Commonwealth Edison by paying the $30

million plus the site and the overhead, and what the estimated cost of fuel which we expect to get from this project, we anticipated that the power will be generated at the site for about 7.5 mills.

That is approximately the cost of power which is generated from a conventional powerplant in our area. In other words, the customer will not be affected in the rates he pays.

Senator BRICKER. There will be no change in the rate base at all?

Mr. LECLAIR. There will be no change in the rate base.

Senator BRICKER. That is all, Mr. Chairman.

Representative PRICE. Dr. Zinn, do you have any questions?

Dr. ZINN. Mr. LeClair has asked me many question in the past. Maybe I should not forego this opportunity to ask him some.

My first one has to do with the statement you made that you are building a dual cycle reactor. The dual cycle you are now working on is not the first dual cycle you had. That is the second, is it not?

Mr. LECLAIR. This is a dual cycle but it is not the same scheme as originally used.

Dr. ZINN. Has that change in scheme delayed the project any?

Mr. LECLAIR. No, that change has not delayed it at all. That is one of the changes that was made in the early scoping of the project, and some of the test on heat transfer, and so on, are going on on schedule.

Dr. ZINN. Do you think there will be any further basic changes in the cycle or do you think it is fixed for good now?

Mr. LECLAIR. We think the basic cycle is fixed and the steam pressure is fixed and those other things. We are satisfied that there will be a number of changes in the details of the design as we go along.

Dr. ZINN. I would like to go back to something that Congressman Price touched on. He mentioned the study group, and I know that in the study group you considered at least the two other reactors beyond those so far mentioned, namely a gas-cooled reactor and also a heavy water moderated and, I believe, cooled reactor. As a result of these studies do you think these plants have technical feasibilities? Do you think they could be built and operated? Would you comment on that.

Mr. LECLAIR. On the gas-cooled reactor we think it is technically feasible. It would be most embarrassing to say it was not, because the British are building some gas-cooled reactors and one of them I understand has already gone critical, so there is no question but that the gas-cooled reactor is technically feasible.

The heavy water moderated reactor, our feasibility study showed to be technically a feasible project. We have to consider the problems that we face in this country. What we are looking for is economical power, and at the present time with the cost of heavy water and our present ideas of the leakage and losses, our feeling was that heavy water might not prove to be economical. I think that is one of those questions that are so close that perhaps further development might change it.

Dr. ZINN. Would you agree to this rather long statement, namely: That your estimates of leakage and losses are only estimates and are not based on experience; secondly, that the price of heavy water has come down since you considered your project; and perhaps thirdly, you were concerned about the fact that purchasing heavy water is a

capital outlay whereas acquiring fuel is an inventory item? Were not these all factors in your decision?

Mr. LeClair. Yes, Dr. Zinn, those were all factors. First of all, the leakage of heavy water was not an academic thing, because when you have been operating powerplants and the cost of water is a few cents a thousand gallons, you are not very much interested in the loss of a few gallons, but when it gets into dollars a pound it is quite different. We think that the leakage could be greatly reduced but we were not certain how much.

On your second one, yes, the price of heavy water has gone down steadily. I am hopeful that the price of heavy water will go down still further.

I have forgotten what the third one was.

Dr. Zinn. The difference between making a capital outlay for the heavy water and, let us say, an inventory charge for fuel. These are somewhat related things, as you know. I had the feeling that you did not like the heavy-water approach to some extent because it required capital outlay whereas acquiring fuel merely required an inventory charge on the fuel, which was owned by the Government. These are related, I believe.

Mr. LeClair. They are related, but I would say our reaction would be based entirely on the overall cost of the power. We would not be too greatly concerned if we had to put more capital in the project because the amount of capital involved in a project such as ours is only a small portion. We have, for example, a 4-year program to spend $600 million for new construction, and to Commonwealth this is $30 million, only 5 percent of the program which is now authorized.

So, a small addition to the capital required would not trouble us if the overall cost of power could be brought down.

Dr. Zinn. Would it be a fair statement to say that you cannot be really sure that the heavy water approach might not have some economic merit even in our county after you consider all these things?

Mr. LeClair. I think it is true to say that heavy water may turn out to be a sound development. In every one of these things that we do, whether it is in the conventional power field or in the nuclear field, over the years the condition does change.

Dr. Zinn. One last question. Are you not of the opinion that the gas-cooled reactor which ultimately could give you really high temperature, perhaps superheated steam, and so on, might not be a pretty sound development provided your materials problems could be solved, and so on?

Mr. LeClair. On the gas-cooled reactor we did make a study, as you know. That was one of the first studies which our group made. At that time the cost of pumping a large volume of gas around in the circuit led us to the belief that under those conditions the economics of the project were not too good. It is conceivable that with the development of larger gas turbines, so the gas could go directly to the turbine in the same way that the forward step was taken from the pressurized water to the boiling water reactor, and put that cooling fluid directly into the turbine, there might be an advantage gained.

I am hopeful that within a few years a gas-cooled turbine will be developed large enough in size that perhaps that project also might warrant development.

Representative Price. Senator Pastore?

Senator PASTORE. Mr. LeClair, of course, I have not had the opportunity to hear all of your statement. I have had occasion to compliment the fine job Commonwealth Edison is doing in this particular field. As I understand it, you are doing this with all your own money and not asking for any Federal help at all. Am I correct in that?

Mr. LECLAIR. Yes, sir. We are using some money from other companies in the nuclear power group, but there is no Government money, that is right.

Senator PASTORE. I was reading your conclusions here. Your last paragraph is to the sense that this is a job that ought to be assigned exclusively to private industry and that the Government ought to stay out of this reactor field completely. Is that the position you take?

Mr. LECLAIR. Our feeling is that private industry can make this field move forward rapidly and reach the goal of economic nuclear power at the greatest speed.

Senator PASTORE. The question that disturbed me is this: Mr. Gore, who has introduced this bill, asking the Government to build six reactors, takes the position that nothing ought to be done either to deter or to impede the efforts that are being made by private industry, but he does go on to say that supplemental to this there ought to be some Government participation to the extent of the Government experimenting in this field to the extent of building six reactors on its own.

If this is to be a supplemental progress—and this, to be sure, is not a complete answer—then why should private industry be reluctant to have Government participation to the extent of building reactors on its own? Why would not that be helpful to private industry rather than impede or deter private industry in any respect?

That is a thing that I cannot seem to reconcile in the position that private industry is taking.

Mr. LECLAIR. I think, Senator Pastore, I am not concerned about any idealogical problems, but the thing that I am thinking about is that we have, as other witnesses have testified, a limited amount of manpower available technically trained to carry on these activities. There is a certain limit beyond which you cannot spread without slowing down the activities which are now underway. To produce actual exact figures on how many men taken from one kind of work will slow down the activity so much is not a very easy thing to do.

Senator PASTORE. Do you feel that the investment of $200 or $300 million on the part of private industry in this tremendous field which might change the entire mode of living of all mankind—after all, this could be cataclysmic in effect—would you say that 200 or 300 million dollars investment on the part of private industry would so exhaust all of the technical know-how in this particular field as to impede the progress that private industry might make? Are we prepared to say that?

Mr. LECLAIR. I do not believe that I would like to make any statement that 200 or 300 million dollars would solve all the problems.

Senator PASTORE. But that is all that private industry, up to this time, has been able to put into this investment. The best figures that we have here is that the entire effort of private industry in this particular regard is between 200 and 300 million dollars, which is the cost to build the aircraft carrier *Forrestal*. That is private industry's

investment in this field, 200 or 300 million dollars. Do you think that is meeting the rivalry between the United States and Russia in this particular field, where Russia is already on a crash program?

Mr. LeClair. I would like to go back just a little bit to consider another phase of it. Let us take our own project as it built up. We began with only a small group of 8 or 10 persons within the 1 utilities organization, as a study team. That expanded to several times that number as a joint group of several companies, as a study team. This is all in addition to taking advantage of the manpower in the Government laboratories, such as Dr. Zinn's and other national laboratories.

Then, we let contracts for the construction of a project, and the manufacturer that had manpower in lots of departments started from nothing and it built up in about a year to a rather substantial organization which is still growing, to work on just this one project. I look at the whole project on the same scale. In other words, the country is just at the starting point for a large expansion. I have the feeling that if the regular law of selection is followed by having the most economical project on a bidding basis comes forward, it is perhaps the best way to achieve success.

I might say even if the Government wishes to spend money to assist in moving the program forward—how many millions I do not know, of course—perhaps the greatest dividends might be obtained by continuing the demonstration program so that private industry or public power groups or any other group that wished to build plants could put into it as much money as they could afford and build up the organization to complete the project.

Then, it might cost the Government less money to give grants-in-aid for the research and development or whatever it might be to get a number of these projects going. That would be another possibility of accomplishing the same end, and it might be less expensive.

Senator Pastore. I cannot go along with that. I am serious about all this. I would only hope this: Private industry does not indulge in cliches with reference to this particular effort, merely the statement of an idealogy. I know that private industry likes to keep the Government out of all activities that belong to private industry, and I am one of those whose philosophy goes along with that idea. I do not think that we ought to have any Government participation which will amount to stepping on the toes of private industry insofar as the progress that private industry is making. But I am pretty much disturbed that here private industry is taking the position, "Look, we cannot get into this wholeheartedly unless we have a solution to the insurance problem."

That is understandable. There is third-party liability. They say, "Look, we cannot put any more of the money of our stockholders into this project excepting that which we can charge off as a research expense for tax purpose."

That, too, is understandable. But it is limited. Then there is a further argument that, "We cannot go into this too strongly unless you do something about the Public Utility Holding Company Act," and I have gone through those hearings.

Here it strikes me that we are setting up marks of limitation on what private industry can do. I am not saying that I do not under-

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stand the plight which private industry finds itself in, but if these limitations are upon private industry then I think that private industry ought to be honest with itself, too, and come in and say, "Look, we can only go so far and this may not be the total effort that the United States ought to be in, and if you want total effort over and above what we are able to put in it, I think Government ought to be in it, too."

Whether it is done by giving grants for research I do not know. Whether it means building six reactors of our own, I do not know. I think it would be a tragic mistake for private industry to come in here and admit that it is limited in the effort that it itself can exert and at the same time be reluctant to having Government participate in it as well.

I hope I make myself clear on that. We are in a rivalry here. We heard yesterday that England is ready to expand from 12 to 22 the reactors it is going to build. All of us know Russia has a regimented economy and if it thinks it can win the hearts and commerce of the world by putting billions into this reactor research, it is going to do it.

The big question here is, How do we meet this rivalry? By doing it in a niggardly fashion ourselves or are we willing to admit that this is still a field in which we need little Government help and that Government ought to be in it if we are to win this race. I think we ought to be frank and honest with ourselves in this.

We should not oppose it only because it is Government participation, as we oppose Government participation in other fields that private industry ought to be in exclusively.

Mr. LeClair. I want to be sure I understand you, Senator Pastore, on some of these questions, because when I say that private industry should do the job, private industry has been doing quite a number of the activities; it has been running some of the Government-owned reactors and has been building most of the components for them. We believe, and I think perhaps the committee does, that private industry is doing a pretty good job.

Senator Pastore. That is right.

Mr. LeClair. We would like to continue. When it comes to the question of a crash program I am not certain whether the crash program has as its objective building a large number of kilowatts or reaching forward to the goal of being the first to have ready designs of reactor powerplants which will make power economical.

Perhaps some of my remarks were directed to the fact that I feel that a major objective is for American industry to produce the best reactor powerplants first, the ones that can meet competition and produce power to meet the low fuel costs which we have in this country.

Senator Pastore. If I am wrong about my interpretation of the Gore bill, I hope someone will correct me. I thought the objective was not to build kilowatts in order to put the Federal Government in the business of generating electric power. I can well understand how private industry might resist that.

As a matter of fact, I would be somewhat opposed to it myself. But I thought that this was merely the question of building reactors in order to perfect the art in this particular field so that we can get to the day of producing electric power competitive with the generation

of electric power through the use of conventional fuels much sooner through Government participation in the building of these six reactors.

I was thinking about the perfection of the article, not the getting into the electric power business on the part of the Government.

If that is the fear that private industry has, I think we ought to have the record straight on that, too.

Mr. LeClair. The Gore bill, of course it is recognized, is a very short bill and perhaps a number of people reading it can get different interpretations. Some of us had the feeling that the purpose of it was to build large powerplants, and others perhaps read it differently.

Senator Pastore. I shall be the first one to ask Senator Gore to state on the record categorically exactly what his objective is in his bill, but it was my idea that the purpose of his bill was supplemental to the effort which is now being made on the part of private industry to build these experimetnal research reactor plants in order to perfect the article so we would be on a competitive basis, and match the international rivalry at a much quicker date.

That was my understanding and that is the reason why I cannot understand why private industry comes in, with the understanding that I have of the bill, and says, "Look, we would rather keep the Government out of this." I cannot see the advantage even to private industry in that position.

Mr. LeClair. Then I think perhaps we are fairly close together because if the objective is to produce economical power, we think it is fine. Then, you come to my informal suggestion that if you want to get the most development of economical power, I would almost wager that by extending the demonstration program you could get more new types of designs built with a given amount of Government money than you can by undertaking the whole job, and at the same time the other scheme would develop know-how in the hands of a larger number of industries that would be building those plants and would be operating those plants.

Senator Pastore. That I go along with. No matter if the Government puts up the money or private industry puts up the money, private industry has to build these plants, and much of our progress, of course, has been done by contracts with private industry. The question I asked at a previous meeting is whether or not, if we did propose to build six of our own reactors, that would more or less impede the progress on the part of private industry, because we would have to use the same technicians and the same scientists.

Of course, that question has not been resolved. I do go along with you. If building six on our part means that we have to use the same personnel that private industry has to use, then I say leave private industry alone to do it. On the other hand, if it means a partnership by which we could get to this day of competitive electric power by the use of nuclear fuel, much sooner by the Government building some reactors, too, so we have something to find out the bugs in good time, even then I think private industry should not resist the Government.

Representative Price. Senator Bricker?

Senator Bricker. No further questions.

Representative Price. Thank you very much, Mr. LeClair. I want to join Senator Pastore in complimenting Commonwealth Edison for the fine work they have been doing in this field. I remember in the

days of the study group your encouragement of that program. I am glad to see some actual work.

I think Commonwealth Edison has certainly cooperated fully in this program and has provided a large amount of the finances on its own.

Mr. LECLAIR. Thank you very much.

Representative PRICE. The next witness is Mr. John N. Keen, manager, Wolverine Electric Cooperative Co.

Mr. Keen, will you come around please?

STATEMENT OF JOHN N. KEEN, MANAGER, WOLVERINE ELECTRIC COOPERATIVE, BIG RAPIDS, MICH.

Mr. KEEN. Thank you Mr. Price.

Mr. Chairman and committee members, I wish to thank you for the opportunity to present the views of the organization which I represent, the Wolverine Electric Cooperative, Big Rapids, Mich., on the reactor industry.

Our cooperative is an REA-financed generation and transmission utility supplying electric energy to approximately 20,000 farms and rural residences throughout central western Michigan through its 3 member distribution cooperatives.

On February 1, 1956, we submitted a proposal to the Atomic Energy Commission for the construction of a small—5,000 to 10,000 kilowatt—nuclear powerplant under the Commission's power demonstration reactor program.

By the way, this was for an aqueous homogeneous reactor. This proposal has been accepted by the Commission for negotiation and we are currently attempting to resolve for contract purposes, the many problems surrounding a project of this kind. We are presenting our views, therefore, as a potential representative of the operating phase of the "reactor industry."

Perhaps the best way for me to express our experience in the development program of civilian application of atomic energy for power production, is to relate to you step by step our experience.

The board of directors of Wolverine Electric Cooperative authorized me, by way of a resolution dated, February 8, 1955, to make a complete investigation pertaining to this matter.

Subsequent to this date, a meeting was held with representatives of the Atomic Energy Commission to discuss the procedure to follow in order to obtain the necessary information to carry out this request. On March 16, 1955, the necessary applications were filed and security clearances requested. On May 31, 1955, Access Permit No. 115 was issued to Wolverine Electric Cooperative by the Atomic Energy Commission.

On June 27, 1955, security clearances were granted to individuals of this organization. This opened the door for Wolverine Electric Cooperative to gather information in regard to the various possible types of reactors that might be suitable for power reactor application. On December 13, 1955, a decision was reached that we should proceed with the reactor program and submit a proposal to the Atomic Energy Commission by February 1, 1956, in compliance with their invitation dated September 21, 1955.

On March 1, 1956, the Atomic Energy Commission study team visited us in Big Rapids, Mich. After an inspection of the proposed site we conferred on pertinent points of our proposal to clear up certain matters in the minds of the Atomic Energy Commission.

On April 18, 1956, an announcement was made by the Atomic Energy Commission stating our proposal was acceptable for the negotiation of contracts. This proposal was the results of the efforts of four companies:

The Foster Wheeler Corp. of New York, the Worthington Corp. of Trenton, N. J., The J. & G. Daverman Co. of Grand Rapids, Mich., consultant engineers for Wolverine, and the Wolverine Electric Cooperative.

In other words, our team was comprised of those four companies. The proposal was basically in three parts: Part 1 requires a research and development program; part 2, contract to construct and operate a reactor plant for the production of electricity; part 3, the construction and operation of a related fuel reprocessing plant. This program also includes a schedule as follows:

February 1, 1956: Proposal submitted to the Atomic Energy Commission.

August 1, 1956: Estimated completion of contracts.

May 1957: Fabrication and erection to start on chemical reprocessing plant.

October 1957: Completion and erection of pilot plant.

Febraury 1958: Completion of chemical reprocessing plant.

May 1958: Start shop fabrication of the nuclear plant.

September 1958: Commencing of field construction.

June 1959: Commencing field testing of reactor.

October 1959: Completion of all tests including field tests and commencing of operation of reactor.

Of course, this schedule calls for many other facilities during this period which are insignificant in regard to the time schedule, as they integrate with the overall program.

I would like to point out that we are but 1 of 35 generation and transmission electric cooperatives under the Rural Electrification Administration Act, and at the present time there are 19 of the electric cooperatives who requested and received access permits, which in my opinion shows a remarkable interest as well as progress in this field.

I understand that there is a bill before Congress, requesting the construction and operation of six reactors for power production. It is presumed that if this bill is approved, 6 power-type reactors will be constructed and operated by the Atomic Energy Commission in 6 different localities in the United States. The Atomic Energy Commission will sell power to utilities operating in the respective areas.

I would like to point out that the announcement made on September 21, 1955, the Atomic Energy Commission, invited proposals for industrial participation in a program whereby power-type reactors within certain power ranges would be considered for an experimental program with the proposal to be submitted by February 1, 1956.

Senator PASTORE. The last sentence in the previous paragraph:

> The Atomic Energy Commission will sell power to utilities operating in the respective areas.

Where did you get that information?

Mr. KEEN. That is a presumption that if they build 6 reactor plants in 6 different areas in the United States to generate power, they will have to dispose of that power to the utilities in the various areas in which each individual reactor is constructed.

Senator PASTORE. But is it your understanding that the primary purpose of building these six reactors is to sell the electric power to perfect the art of building reactors in order to generate electric power through the use of nuclear fields?

Mr. KEEN. That is a matter of interpretation, I presume. My interpretation is that if there were 6 reactors built in 6 different geographic areas in the United States to produce power, the primary purpose would be to produce power and the secondary purpose would be to better learn the art. Otherwise, in my opinion, if the reactors were built as a laboratory model then it would be definitely to increase the art primarily and not to sell power or manufacture power.

Senator PASTORE. It is your definite impression that the purpose of this bill is to put the Government in the business of producing electric power?

Mr. KEEN. That is my interpretation, sir. Otherwise, they would be built in the laboratories.

During this period of a little over 4 months, 7 proposals were received by the Atomic Energy Commission. It is my understanding these proposals were quite varied in scope as well as geographical locations. This points out that industry is ready and willing to enter into the field and apparently is well prepared to do so.

Therefore, I question the wisdom, for the Atomic Energy Commission to deviate from the established pattern and construct six reactors to prove their capability of power production whereby these reactors will be entirely financed by taxpayers' money.

There are however, a few roadblocks hindering the civilian program, such as: The insurance program, patent rights, classification of data relating to the nuclear energy as applied to power, and governmental monopoly and control of fissionable and fertile materials.

In conclusion, even though we were able to make a complete investigation in a field that was foreign to us but a few months ago, the assistance we received from the Atomic Energy Commission, the Rural Electrification Administration, and others enabled us to prepare a comprehensive proposal for the construction of an aqueous homogeneous reactor that will greatly advance and benefit this program.

We feel if the insurance program is solved, patent rights extended, the materials declassified as applied to power reactors, and governmental monopoly be removed from fissionable and fertile materials, this program could be further accelerated.

Representative PRICE. Senator Pastore?

Senator PASTORE. There is only one point I wish to clear up, and of course, I do not want to get into a discussion about this because I think the best man to clear this point up is Mr. Gore himself, who is sponsoring this bill.

The impression that I get from the experts is that while you may build small experimental reactors on a very, very small scale, the fact of the matter is that if you want to develop this particular industry or this art, you have to get into full scale reactors. The reactors that we are talking about here under the Gore bill are full

scale reactors such as have been talked about by other people who come here, such as Commonwealth Edison.

Primarily, as I understand it, the construction of these full scale reactors is to perfect the art rather than put the Government in the business of generating steam or heat in order to produce and sell electric power throughout the country. In other words, the purpose here is not to socialize the electric power industry but merely to promote the day of building reactors in order to competitively generate power through the use of nuclear fuels.

Mr. KEEN. Senator Pastore, in my opinion the art would be further aided by having the Atomic Energy Commission do as it is now doing, that is, jointly assist industry in this development program in the way that will most greatly benefit the United States in general. I fully believe that industry is willing and able and ready to take on the full scale reactor program with the proper assistance from the Atomic Energy Commission.

However, there is a great need for further advancement and further research and development along certain lines.

Senator PASTORE. I realize that that is your opinion. Of course there are others in the field—Dr. Zinn is one of them and I think there are few men in this country who have had more experience than he has had in this particular field—who feel that you have to get into the building of full scale reactors if you are really going to know what the problems are.

I understood the Gore bill was nothing more than that, to build these full scale reactors supplementary to the effort already being made by private industry, just so we will get enough done in order to improve this art and bring about the day at a faster rate when we will have electric power through the use of nuclear fuels competitive with the use of conventional fuels.

Mr. KEEN. Senator Pastore, if the bottleneck at the present time is personnel, this is a new field, and our colleges are just beginning to teach this type of field at the present time. Is it due to the lack of personnel at the present time or is it due to the lack of having enough full scale reactors in operation?

Senator PASTORE. That may be so, but if we took that attitude we would not have had the atomic bomb first, we would not have had the hydrogen bomb first, and we would not have the stockpile we have in America. I am not willing to admit that there is such a dearth of experts and technicians in this country that we cannot afford to spend more than $300 million in this field. I am not ready to admit that yet.

Mr. KEEN. I would not, either. I also feel that this last demonstration when an invitation which was made on September 21, with a deadline of February 1, 1956—in other words a period of a little over 4 months time—and 7 different types of reactors were proposed and they were varied in scope, proves that industry is ready to start the construction of full scale reactors.

Mr. PASTORE. I hope you are right.

Mr. KEEN. So do I, sir.

Representative PRICE. I am interested, Mr. Keen, that you take almost an opposite position from that of the very man who is a designer

and developer of the reactor in which your company is interested, Dr. Weinberg. He made this statement here a few days ago. He said:

As I said, we have in this country 4 or 5 firm proposals for large scale power demonstration reactors. In order really to meet the foreign competition—

and I refer to foreign competition with respect to using nuclear energy as an instrument of national policy—that is one thing we may be overlooking in all of our discussions.

I believe that a country as large and strong and vigorous as ours should have several more large scale propositions actually underway.

You take almost the opposite view?

Mr. KEEN. I feel that way, too, Mr. Price. As my statement here proposes, I feel that the Commission should stay on the line they are on now. In other words, make more invitations, go into this thing jointly between the Atomic Energy Commission and industry and continue that way.

After all, back at Lexington and the minutemen—

Representative PRICE. Of course, Dr. Weinberg went on further to state that the economic incentive of this country would not be such as to accomplish this that we had to do it more or less as a national policy. Undoubtedly, you are concerned with the economic incentive. It would not be there, so it would be a matter of national policy.

Mr. KEEN. I have another question in my mind. If the Atomic Energy Commission constructed, let us say, six different full scale reactors, I presume that there would be generation facilities attached to those reactors to generate the power to prove their merit. If the Atomic Energy Commission built them and operated them, they would want to operate them as an experiment, not as a utility would perhaps wish to operate such a reactor, to gain the utility experience.

Whether that would be a handicap to the amount of power that was available, whether it would be dependable power or whether it would not——

Representative PRICE. You are familiar with the Shippingport reactor, which will be operated by Duquesne Power & Light Co. I would like to ask you a few questions about your own project. Who within your organization conceived the idea of going into this atomic reactor program?

Mr. KEEN. We have kept right close to the reactor field since it has been announced, since World War II.

Representative PRICE. What is your present source of electrical energy?

Mr. KEEN. Our present source is internal combustion.

Representative PRICE. You operate your own generating plant?

Mr. KEEN. We have four plants throughout west central Michigan.

Representative PRICE. What is your average kilowatt cost?

Mr. KEEN. The cost per kilowatt-hour? The board cost of produced power at the plant is about 7¾ mills to 8 mills.

Representative PRICE. With your atomic reactor do you hope to cut that cost?

Mr. KEEN. I am very happy you asked that question because we feel that this program is a development program and we at Wolverine are willing to make a total investment for power to equal what our present power cost is, and we are now in a very high power cost area. Therefore, we can afford to put enough money into both the construc-

tion and operation of this plant to equal our 7½- or 8-mill power that we are producing today. That is what we propose to do here.

In other words, the amount of money that Wolverine is contributing to this reactor program, in this one reactor, is enough to equal conventional costs. We hope to gain on this by having a second reactor, so to speak, after this one has proved itself, and of course, it will be much cheaper after the first one is constructed.

Representative PRICE. Suppose it turned out to be 15 mills per kilowatt, who is going to pay that difference?

Mr. KEEN. The way our contracts are, we know it will not turn out to be 15 mills, sir.

Representative PRICE. How can you tell?

Mr. KEEN. We know what the heat balances are. We are guaranteed, I presume, by the Atomic Energy Commission and by the Government, our fuel costs for the next 5-year period. We know what they are going to be. I understand they are firm prices.

Representative PRICE. What do you estimate the price will be per kilowatt?

Mr. KEEN. I will give you our complete estimate here. During 1960, that is when we will be operating the reactor partial time due to its still being new and experimental, 10 mills. During 1961, 8.9 mills. During 1962, 8 mills. During 1963, which is when we will be in full operation with about 10,000 capacity, 7.9 mills. Then, down to steady operation in 1965, 7.5 mills.

Representative PRICE. Did you not say that your average cost now is 7 mills?

Mr. KEEN. It is 7.8.

Representative PRICE. Do you feel that the reactor will be as feasible in that area as your existing source of electrical energy supply?

Mr. KEEN. We are, sir. We also feel that due to our past experience, our costs will not remain where they are today on conventional generation. Going back to 1941, our fuel costs for fuel oil in that area were 3.3 cents per gallon of fuel. Today, that same fuel oil is selling in the same locality for 13 and 14 cents; in other words, between a 400 and 500 percent increase in 15 years' time.

Representative PRICE. Dr. Zinn, would you like to ask any questions on that point? That is a very interesting point.

Dr. ZINN. Yes, indeed; I would like to ask Mr. Keen some questions.

You are predicting a 7.5 mill power cost from a plant whose generating capacity is only 10,000 kilowatts?

Mr. KEEN. That is right, sir.

Dr. ZINN. Things being as they are, if one aqueous homogeneous plant of this same general design for, let us say, 100,000-kilowatt capacity, one certainly would get an improvement in cost of a couple of mills. In other words, we would get to 5.5 mills per kilowatt-hour power. This is already better than conventional power in many areas of this country. So if what you are predicting here can actually be done, would not it make sense to immediately embark on some large-scale plant of this size, because they are surely economically competitive right in our own country?

Many of these problems which have been posed with respect to uneconomic plants, and so on, vanish. Is not this a correct statement?

Mr. KEEN. I believe so, and I believe the Detroit Edison Co. is working on a project very similar to ours. They have the breeder

type which is quite similar in a lot of respects to the aqueous homogeneous reactor.

Dr. ZINN. Sir, if I may say so, I am very familiar with the fast breeder type of reactor and there is no chance whatsoever that one could build a 10,000-kilowatt fast breeder powerplant now giving power at 7.5 mills, not even at 27.5 mills.

Representative PRICE. There should be no higher authority on fast-breeder reactors since you are the father of it.

Dr. ZINN. If it is really so that your plant which you are proposing does not have hidden in it anywhere, any subsidy from any equipment manufacturers or otherwise, then actually the future is extremely bright.

Now, is there a subsidy from the manufacturer or equipment supplier in your plant?

Mr. KEEN. Definitely so.

Dr. ZINN. Then, it is not really so for someone who could not get this subsidy. Since I believe the equipment manufacturers have a limited ability to subsidize the plants of their customers, is it so that this is not actually the way I described it? We do not have economic power actually at hand.

Mr. KEEN. We do not expect to have economic power out of the first reactor, mainly due to the research and development program which must take place on any new experiment before it can be completed. That research and development program, of course, applies in this case to this particular reactor and if it proves successful then it will not apply to the other reactor of this same exact design because a research and development program will not be necessary.

Dr. ZINN. You will agree with me that at Oak Ridge the Government has spent, let us say, at least the $50 million on research and development of aqueous homogeneous reactors? I do not know what the figure is, but I am just saying $50 million.

Mr. KEEN. I do not know what the figure is, either, sir, but I do know if it had not been for the research and development program at Oak Ridge we would not be proposing this homogeneous reactor today.

Dr. ZINN. Yes. Oak Ridge is actually building at this time, aqueous homogeneous reactor of about 10,000 kilowatts electrical generating capacity. How much money is your company and associated groups spending for research and development to produce a plant of design not very much different from the Oak Ridge plant?

Mr. KEEN. It will be single stage, whereas I believe Oak Ridge is two stage.

Dr. ZINN. So, you are taking the easier path, the single region reactor, the easier one to build. It avoids a lot of problems having to do with corrosion and so on. What kind of money are you putting into the research and development?

Mr. KEEN. $1,300,000.

Dr. ZINN. So, to build the easier type of reactor of the same scale and size that Oak Ridge is building, $1,300,000 is going in. Oak Ridge is still spending, I do not know what rate, but it is a sizable rate, on the same type of reactor. I think the question that the committee has really under review is: If this looks so good to you, and so on, would you agree that now is the time to build, let us say, a single region, large-scale homogeneous reactor? Even though, also, I would

agree that maybe your plant is not economical, would not a larger one have a better chance?

Mr. KEEN. That is very possible. I cannot answer that in the first place because we are not interested in the large reactors. Our particular utility in Michigan is serving a limited area. It has a limited number of customers, a limited number of members. We are interested only in the small, up to 50,000-kilowatt capacity or 50 megawatts. Therefore, we have not burdened our studies with the large-scale reactors, but I am sure that the utilities as a whole are watching that experiment being conducted at Oak Ridge at this time, just as we were, so they can get into this field in the larger sizes.

I do feel that the experiments such as are going on at Oak Ridge, of which an example is the aqueous homogeneous reactor experiment down there now, are very helpful to the industry as a whole and very helpful to the utilities. I think that is the type of work that the Atomic Energy Commission should concentrate themselves on to bring out that type of work instead of building full-scale operating type reactors throughout various parts of the country.

Dr. ZINN. But do you not admit that you cannot really find out on small reactors whether or not you have economically competitive power? Would you not always have expensive power if you just look at the little ones?

Mr. KEEN. Sir, that depends upon what part of the country you are representing, of course. In the TVA area, yes, that would be expensive power, but up in Michigan, Minnesota, and so forth, the small reactors can play a very important part.

Senator PASTORE. That is not what Dr. Zinn said. Dr. Zinn said if we are intent upon developing this art, developing these large reactors which one day will produce electric power competitive with the use of conventional fuel, the best way to do it is to build full-scale reactors. What is so wrong with that? Why does private industry oppose that? Why do they consider that that is an encroachment upon their efforts? If it all means that we are trying to promote the same objective of developing these reactors full-scale, in order to prove that we can produce this current just as cheap with nuclear fuel as we can with conventional fuels, what is the great opposition to it?

For the life of me, I cannot understand it. Why do you feel that that takes something away from you? Why is not that helpful to you?

Mr. KEEN. Senator Pastore, I do not recall making the statement that we felt that the Atomic Energy Commission by building full-scale reactors would be jeopardizing the industry. If I did, I stand corrected because I did not mean that. But I do feel ——

Senator PASTORE. I do not mean jeopardizing the industry. I say it would help the industry. It would not be an encroachment upon their effort.

Mr. KEEN. I feel that it should be a joint venture between industry and the Atomic Energy Commission, that we should go on as we have in the past and do things jointly. I believe it can be carried out that way just as fast or perhaps faster than if we went separate routes.

Senator PASTORE. What do you mean, we have been doing it in the past? We have not been doing it at all. We have no plants today that are manufacturing electric power from the use of nuclear fuels on any large scale at all. The only plant that I understand is going

to be an operating plant, and it is not today, is the Shippingport plant. Do you know of any besides that?

Mr. KEEN. In operation now, no, sir.

Senator PASTORE. That is the point. Why do we keep on saying, "Let us go on the way we have been going"? We have been going on in a complete vacuum.

Mr. KEEN. Senator Pastore, do you believe the Atomic Energy Commission could design, construct, and put in operation a reactor plant any speedier than, say, the next 7 or 8 reactor plants will be going on the line?

Senator PASTORE. I think so, if private industry does not get much of the relief they are asking for. We have heard here that before any company can put any money in this research it has to get permission of the local supervising authority. In other words, the public utility administrator in the State wants to know that they are not going to jeopardize the cost of current to the consumers, and therefore they are limited in how much money they can put in such a joint effort.

If we are going to have a limitation there, we are certainly not going to meet the rivalry that we are receiving from Great Britain and the rivalry that we are receiving from Russia. If that is the picture, it strikes me that we need a little more to be done. All that Senator Gore suggests is that the Government in addition to private industry start building some of these reactors, too, not as an exclusive monopoly in this field, but only as supplemental to the effort already being made by private enterprise.

If the Government does this and does it without an encroachment on private industry and promotes the art, why is not that advantageous to private industry, too?

Mr. KEEN. Senator, if that could be done without duplication of efforts and half the end result come out to the utility level to be operated as utilities are operating without any additional cost to the Government, I think it would be a fine idea.

Senator PASTORE. Now, we are beginning to agree with one another. That is precisely what I understand this bill proposes to do. If it does not propose to do that, then I think we ought to be told that. I think that Senator Gore has made his position pretty clear. He wants private industry to do all that it can. He wants private industry to be encouraged by the Government.

However, he thinks that the effort on the part of private industry with all its limitations is just not quite enough. For that reason, if we are to meet this rivalry, the Government ought to do a little something on its own power. That is all he is suggesting. If that is the case, I think myself, private industry ought to come in here and applaud.

Mr. KEEN. Senator Pastore, that is what I have been trying to say. We should work together as a team on this, both industry and the Atomic Energy Commission combined. In that way, we will get further than we will in any other way.

Representative PRICE. I am curious to know, Mr. Keen, whether or not the Atomic Energy Commission team working on your proposal agreed with your optimism on your rates and the cost per kilowatt?

Mr. KEEN. There was a study team assigned to our proposal headed by Jon Anderson, who is the manager of the Schenectady Operations Office. He had a seven-man team, I believe, representing various

functions of the Atomic Energy Commission. They apparently agreed with us because they gave a favorable recommendation to the Commission and the Commission approved our proposal.

Representative PRICE. Were these figures discussed?

Mr. KEEN. These figures were in our proposal.

Representative PRICE. Did they agree with these figures?

Mr. KEEN. They did.

Representative PRICE. I do not recall any testimony before the committee of such optimism on the part of the Commission about obtaining economically feasible competitive power.

Mr. KEEN. These figures I read to you were an excerpt from our proposal, supplement No. 1, dated March 23, 1956.

Representative PRICE. Certainly, that is not the highest power rate area in the country.

Mr. KEEN. It is one of the highest, but not the highest.

Representative PRICE. What is the highest area?

Mr. KEEN. I could not tell you for sure, sir, but I believe there are 2 or 3 areas considered quite high. One is the Midwest, North and South Dakota.

Representative PRICE. What is the highest rate that you know of in the United States?

Mr. KEEN. In the United States? I do not know, sir. I could not tell you for sure. I am of the opinion that it is around 15 mills. It might be a little higher than that up in the New England States.

Dr. ZINN. Mr. Price, there is no really considerable amount of power in this country where the cost is more than about 9 mills.

Representative PRICE. If what you say is correct, if your optimism is justified, then the Commission has been woefully negligent in not expressing it here to this committee because I do not remember the Commission at any time telling us of any area of the country where they were in a position to meet power rates on a competitive basis. Do you recall that?

Senator PASTORE. No. sir.

Mr. KEEN. The Commission announced their approval of our proposal on April 18, of this year, and these figures I quoted to you are excerpts from our proposal.

Representative PRICE. Has the company which is to build your reactor built any other reactor?

Mr. KEEN. They have done a considerable amount of work in the reactor industry. I presume that some of you Congressmen are familiar with some of the activities they are in, which I am not in a position to quote here because it has to do with the military. However, to give you some of the activities that they are in——

Representative PRICE. The answer is that they have never built a reactor, is that not true?

Mr. KEEN. I believe this gentleman on your right there perhaps could help me out a minute.

Dr. ZINN. The answer is "No".

Mr. KEEN. Would you care to say anything about the experiments being carried on at Oak Ridge, as to Foster Wheeler's participation in that?

Dr. ZINN. I am familiar with what is going on, but I say really they have never built a reactor. There are lots of companies which have not built a reactor. Most of them have not.

Mr. KEEN. But they have built a number of component parts.

Dr. ZINN. Surely, yes.

Representative PRICE. We are glad to see new contractors come into the field of building reactors, but at this point it is an uncertainty.

Thank you very much, Mr. Keen. We appreciate your testimony.

Mr. KEEN. Thank you, Mr. Price and gentlemen.

Rpresentative PRICE. The next witness is Mr. John R. Lamarsh, Associated University, Brookhaven Laboratory.

Dr. Lamarsh?

STATEMENT OF JOHN R. LAMARSH, ASSOCIATED UNIVERSITIES, BROOKHAVEN NATIONAL LABORATORY

Mr. LAMARSH. Mr. Chairman and gentlemen of the committee, my name is John R. Lamarsh. I am a nuclear physicist at Brookhaven National Laboratory, Upton, N. Y. I am appearing today in response to the suggestion of Senator Gore that my remarks might prove of interest to the committee. My remarks, however, are those of a private citizen and to not necessarily represent the views of the laboratory or the Atomic Energy Commission.

The bill introduced by Senator Gore has the commendable purpose to advance the art of generation of electric power from nuclear energy. As it has been stated many times, the United States must not be allowed to lag behind other nations in developing the know-how of nuclear power, and the bill, I am sure, would do much to keep this Nation at the forefront of this rapidly expanding field.

There is, however, another aspect of the nuclear development program which to my knowledge has not been widely considered. This is the important role which stationary nuclear powerplants could play in the survival of the Nation in an atomic war. In this sense, the concept of the present bill besides providing additional momentum to our nuclear technology could very directly contribute to the national security.

To explain this point, I should like to consider, in a somewhat Olympian way, some of the consequences of an atomic war. To begin with, it is well known that at the present time the Soviet Union has the capability to deliver both ordinary atomic bombs and thermonuclear bombs in substantial numbers to targets in the United States.

Furthermore, it has been reported that their strategic air arm is now being enlarged at a greater rate than is our own.

In addition, as President Eisenhower recently admitted, they may be ahead of us in certain aspects of the development of an intercontinental ballistics missile. Thus, the threat to this Nation has never before been so great, and the recent Soviet announcement of a reduction in the size of their army does not necessarily lessen this threat since it more than likely indicates their greater reliance upon air power.

Suppose now, that the Soviet Union has launched a massive atomic attack. Let us say that it has been fairly successful and that the bulk of the prime targets in the United States have been hit.

The effect would be staggering; a large porportion of our population would become casualties, much of our industry would be destroyed, and so on.

I in no way wish to underrate such a catastrophe, but in some sense these losses are irrelevant to the main issue which is that of survival of the free world as such. They are irrelevant to the question since presumably we can count on a largely equivalent attack by ourselves and our allies upon the aggressor nations. The strengths of the great powers would be reduced, but simultaneously.

The situation is not unlike that of an early exchange of queens in chess. The exchange does not affect the outcome of the game, in principle at least; it merely makes the subsequent play rather dull and uninteresting.

In spite of the massive destructiveness of an atomic attack, I cannot believe that this Nation would be completely annihilated. In any event, it is very difficult to plan for oblivion. I think that it is reasonable to assume that there would remain many areas of the country having only minor target value which would be left relatively intact.

It is upon these areas which the Nation would depend both for the rehabilitation of the devastated regions and for the continuation of the war effort. They would be the remaining chessmen, so to speak, in the game of survival. It is, therefore, important that we should insure that these areas would be capable of fulfilling such unprecedented responsibilities, should the need arise.

There are a number of items which such areas would require in order to do this. They would need, among other things, food, water, and medical supplies both for their own population and for refugees. But, in addition, they would have to have electrical power.

The importance of electricity in our daily affairs cannot be overemphasized. Any modern community would cease to exist as such if it lost its ability to generate electrical power. At a time when the survival of the Nation depends upon certain intact areas, it would indeed be pathetic if this were also a time when these areas were without power.

Yet, this is precisely what would happen to many of these regions. This is because the generation of electricity in conventional power plants is dependent upon the delivery to the installations of enormous supplies of coal and oil. Since many parts of the country are located at large distances from the sources of these fuels, the mines and oil fields, the generation of power in these areas is dependent upon a complex transportation system, and herein lies a serious problem.

Consider first the transportation of coal. Coal is carried largely by rail, though in some cases it is transshipped by boat. A glance at the national railroad map will show that the rail system consists of a vast network of lines which meet in massive junctions.

For obvious reasons, the location of these junctions practically always coincides with large centers of industry and population, and, as the rail net now functions, it is not an easy matter to travel over large distances without passing through several of these centers.

Since we have assumed that such major targets would be destroyed early in an atomic war we must conclude that there would result a very serious stagnation of the national rail system. The transportation of large amounts of coal to the plants in the unaffected regions would be seriously curtailed. Railroads, of course, can be repaired, as they were following the bombings of World War II. But the damage from nuclear weapons will be considerably greater, and new rolling stock

rails, and so forth, and necessary personnel are likely to be either in very short supply or entirely unavailable.

Those rail facilities which would be functioning would probably be clogged with many other vital commodities, and it would be manifestly ridiculous if at the same time we also had to transport millions of tons of material which at its destination were merely thrown into a fire.

The situation with regard to the national oil supply is just as serious. This is not only because of the manner in which oil is transported but also because of the more concentrated nature of the industry. In this latter connection, John L. Lewis recently pointed out that the destruction of 10 major oil-refining centers would probably result in stagnation of the industry.

The long-distance transportation of oil is accomplished in three ways; by rail, sea, and pipeline. My earlier remarks with regard to the rail shipment of coal apply also to oil. The sea transport of oil is also quite vulnerable since our major harbor installations are prime atomic targets and since Soviet submarines are probably capable of destroying the bulk of our tanker fleet. New ships to replace these will not be readily available since the bulk of our shipbuilding industry and its suppliers is located in the prime target areas.

An increasing amount of oil is being carried by pipelines, and the vulnerability of this system is open to some question. But while an initial atomic attack upon the United States would not entirely destroy the network it would do considerable damage to it, particularly at the terminal points.

If these remarks represent a plausible picture of some of the consequences of an atomic war, we must conclude that the present conventional power system is not entirely appropriate for the problems posed by such a war. Vast areas of the country which were not directly involved in an atomic attack might well find themselves suffering from an acute power shortage.

Yet, as already mentioned, it is upon just such areas that the Nation would depend not only in aiding in the rehabilitation of devastated regions but also in supplying the impetus for subsequent actions of the Armed Forces.

Before the advent of nuclear power, the only means of insuring the uninterrupted production of electrical power in all regions of the Nation would involve the stockpiling of enormous amounts of fossil fuels, and this would be a very uneconomical undertaking. The generation of electricity in nuclear powerplants, however, is a far simpler process than it is in conventional plants.

For one thing, there is no massive bulk of fuel involved and therefore there is no fuel transportation problem as there is with coal and oil. Thus, if prior to the outbreak of an atomic war, some of our smaller communities were supplied with electrical power generated by nuclear reactors located in the area, there would be no interruption in this vital commodity after the major national centers had been wiped out, provided only that a small stockpile of nuclear fuel were maintained near each reactor.

The actual amount of this fuel that would have to be stockpiled is not large. For instance, only a few hundred pounds of enriched uranium are required to keep a fairly large reactor in operation for years.

It is also important to note that nuclear fuel requires no special facilities for its storage, and it does not deteriorate. It can as easily be stored along with the reactor which it supplies, as stored anywhere else in the country.

From the standpoint of national defense, therefore, the development and construction of stationary nuclear powerplants, in what might be called secondary key areas could be of crucial importance.

Therefore, it would appear incumbent upon the Government to support a research and development program which would eventually lead to the generation of nuclear power in such regions.

There are a great many of these throughout the country. I would like to conclude with an example of one in particular which in wartime would profit from the prior establishment of nuclear power stations. My choice here is based solely upon familiarity. Long Island, besides being a normally heavily populated area, and a probable refuge for massive numbers of survivors of an attack on New York City, is also the site of a number of installations which would be important to a war effort.

These include Republic Aviation, Grumman Aviation, and the Sperry division of General Dynamics Corp., all located on the western part of the island, and Brookshaven National Laboratory and a branch of Grumman Aviation on the eastern end of the Island.

Although we may expect that a great deal of the New York metropolitan area will be devastated during the early stages of an atomic war, it is not necessary to assume that all of the island will be hit immediately.

In particular, I am assuming that the fallout does not occur on the island. Now, the bulk of the power for all of Long Island east of New York City is supplied by one utility company which consumes considerably over a million tons of coal and a much smaller amount of oil yearly in its plants to produce about 700 megawatts of power.

The transportation of the coal from the mines to the Long Island plants is a fairly complicated affair. It is first moved from the mines in West Virginia by rail to docking facilities in the New York City area where it is reloaded onto barges which carry it to the power stations located along the Long Island shore.

Clearly, a thermonuclear blast over the city would render such procedures impossible for an extended period. In addition, many of the great rail junctions between New York and West Virginia probably would have been destroyed. The delivery of large quantities of coal to the island would prove a very difficult task. However, one or two 100-megawatt nuclear power stations located, together with a few hundred pounds of uranium fuel elements, anywhere on the island except near the New York City line would be sufficient to sustain a minimum of life and industry in such a circumstance without interruption for years.

My point briefly is that an atomic war would in effect compromise much of our power industry even in regions of the country which were not immediately involved. Stationary nuclear power installations present a means of which the Nation can stockpile power. Our present supply of enriched nuclear fuel probably represents a very considerable theoretical power reserve. This will, however, remain

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an impotent stockpile until we have the nuclear reactors capable of using it.

Representative PRICE. Dr. Lamarsh, that is a very interesting statement. I assure you that you have mentioned several things which have come to the attention of members of the committee. The chairman of the committee, Mr. Anderson, a few days ago expressed himself almost identically as you have. I think you have prepared a very interesting statement to the committee.

Dr. Zinn, would you like to add anything?

Dr. ZINN. Yes, I have several questions.

First of all, Dr. Lamarsh, are you a reactor physicist or a nuclear physicist?

Dr. LAMARSH. At the present time, sir, I am both, I am afraid.

Dr. ZINN. Of course, Doctor, I am intrigued by your statement on page 5, which says, "The generation of electricity in nuclear powerplants, however, is a far simpler process than it is in the conventional plants."

If it is far simpler, why cannot it be cheaper?

Dr. LAMARSH. That is a good question. It is a far simpler process in principle in some respects, I think, and perhaps some day it will be more economical. I hope so.

Dr. ZINN. Would you perhaps agree that the generation of power in conventional plants has had 100 years of development and atomic power has had perhaps 10 years of development?

Dr. LAMARSH. That is right.

Dr. ZINN. This is perhaps the reason why it is not cheaper.

Dr. LAMARSH. I think that is probably true.

Dr. ZINN. Your suggestion, of course, is an extremely important one. I wonder if you have thought of the fact—I am sure you have—that just as vulnerable as our transportation of coal and so on, is our transportation of electricity? High tension lines also have a habit of passing close to populated centers. In the case of any large-scale bombing they would be taken out. So, even though you might not lose your coal supply, you lose your transmission ability fairly soon.

Dr. LAMARSH. I think that would probably be something that would be more easily replaced, however, than the transportation system.

Dr. ZINN. That is true.

Dr. LAMARSH. I believe that is so.

Dr. ZINN. I believe the materials for repairing high tensions are easier to come by and are not so heavy as railroad lines.

You suggest here reactor plants of the 100 megawatts power. These, of course, would be located normally very close to large population centers because of transmission difficulties. They might still be within the bomb range.

Dr. LAMARSH. That is true, but I think it depends upon what one means by a large population area. For instance, on Long Island, which is just one area I happen to know something about, there are a number of reactors which are 160 megawatts, for example, in power, which are located near cities or towns which I doubt very much would immediately be subjected to an attack.

Dr. ZINN. You mean there are 160 megawatt coal-fired stations within 15 miles on the island?

Dr. LAMARSH. Oh, yes, all the way out, 70 or 80 or 90 miles out there are stations which are 100 megawatts, 160 megawatts and so on.

There are a great many of those.

Dr. ZINN. Then, the population density on the island must be somewhat higher than I thought it was.

That is all the questions I have.

Representative PRICE. Thank you very much, Dr. Lamarsh.

Dr. LAMARSH. Thank you, gentlemen.

Representative PRICE. Tomorrow will be the final day of the current hearing on the proposed acceleration of the civilian reactor program.

The hearing will be held in the Senate District Committee room, P–38 in the Capitol at 10 a. m., Tuesday, May 29, 1956.

The committee will now recess.

(Whereupon, at 4:37 p. m., Monday, May 28, 1956, the joint committee recessed to reconvene at 10 a. m., Tuesday, May 29, 1956.)

ACCELERATING CIVILIAN REACTOR PROGRAM

TUESDAY, MAY 29, 1956

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D. C.

The Joint Committee met at 10 a. m., pursuant to recess, in room P-38, the Capitol, Senator Clinton P. Anderson (chairman of the Joint Committee) presiding.

Present: Senators Anderson, Pastore, Jackson and Gore.

Present also: James T. Ramey, executive director, George Norris, Jr., George E. Brown, Jr., Wayne P. Brobeck, and David R. Toll, of the Joint Committee staff.

Senator PASTORE (presiding). The hearing will please come to order.

Our first witness this morning is Mr. James Fairman, vice president of the Consolidated Edison Company of New York.

Are you ready, sir?

STATEMENT OF JAMES F. FAIRMAN, VICE PRESIDENT, CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

Mr. FAIRMAN. I am, sir.

My name is James F. Fairman. I am vice president in charge of engineering of Consolidated Edison Co., and as such I am supervising the company's reactor program as one of my major functions.

I am also a member of the board of directors and executive committee of Atomic Power Development Associates, Inc., which is doing research and development work on a fast neutron breeder reactor.

I have served in various capacities with Con Edison and one of its corporate predecessors since 1925. I have been one of its vice presidents for the past 10 years. My duties have been directly concerned with electric and gas production and distribution.

I am a registered professional engineer and received a bachelor's and a master's degree from the University of Michigan.

From July 1, 1951, to November 30, 1952, I served as Defense Electric Power Administrator in the Department of the Interior, on leave of absence from the company.

In his statement to your committee on May 16, Mr. Searing stated that we would present a detailed status report on our project in these hearings. I am here for that purpose, together wih Mr. Gordon R. Milne, the mechanical engineer of the company, and Mr. John W. Landis, assistant manager of the atomic energy division of the Babcock & Wilcox Co., our contractor for the reactor portion of our plant.

Also with me is our counsel, Mr. Arvin E. Upton, of Washington, a member of the firm of LeBoeuf, Lamb & Leiby.

Before making our status report, I should like to make a few comments on the philosophy of our program as it may relate to the bill under study in these hearings.

When Mr. Searing appeared before you on February 10, of last year, he said that the enactment of the Atomic Energy Act of 1954 encouraged us to begin discussions with manufacturers to determine whether there was a reactor which we could build now and which would accelerate the development of the art.

These discussions resulted in a contract with the Babcock & Wilcox Co. on March 18, 1955. Shortly thereafter we filed our application for licenses with the Atomic Energy Commission.

I have referred to our statement of last year to emphasize that the 1954 act has been a decisive factor in our activities. The act was a challenge to, and an opportunity for, private industry.

At the same time, it imposed upon industry, a responsibility as the "chosen instrument" of national policy to advance one of the most important peaceful uses of atomic energy.

Senator GORE. May I ask a question?

Senator PASTORE. Yes.

Senator GORE. I know you quote "chosen instrument." From what are you quoting?

Mr. FAIRMAN. That quote is just a form of expression.

Senator GORE. I understand.

Mr. FAIRMAN. I don't know that it exists in the legislation.

I would like to tell you a little about our conception of what this opportunity and responsibility mean to us at Consolidated Edison because it may help you judge whether a new Government undertaking is needed as proposed by Senator Gore.

We are not suffering from a power shortage in this country. We are not in immediate danger of running short of a supply of conventional fuels. Probably electricity produced from atomic energy will not be competitive with that produced from conventional energy sources for several years, although we are optimistic that it will be competitive much sooner than many people think.

Why, then, are we planning to build a nuclear steam generating plant?

First of all, because we think we owe a duty to our stockholders to keep abreast and, if possible, ahead of technological factors affecting our industry.

Second, because as a business affected with the public interest we have a similar duty to our consumers. The time to prepare for tomorrow is today. Tomorrow atomic power will be a business proposition and not just a developmental one.

These factors alone would certainly have been enough to persuade us to go ahead with our program.

In addition to these factors, we appreciate the unique nature of the effort of which we are a part. Like other citizens, who follow the course of world events in the press and in periodicals, we know something of the difficulties involved in maintaining American influence in the undeveloped areas of the world. We are not unmindful of the fact that our program, and others similar to it, can play a significant part in helping this country maintain its position in those areas.

I have mentioned all of these factors, Mr. Chairman, because I want to make it clear that our company is engaged in a serious and substantial program. We recognize that we have a definite moral obligation to proceed with our program, and we intend to do so unless technological problems arise of such a nature as to slow up any atomic power program, Government or private.

In our opinion, we and our contractor, Babcock & Wilcox, are now proceeding as fast as sound application of a new technology will permit.

Senator PASTORE. Would you mind an interruption at this time?

Mr. FAIRMAN. Not at all.

Senator PASTORE. First of all, I want to say how pleased all of the members of the committee are with this job your company is doing; I think I speak the sentiment of all of the members. We all feel that your company is doing a marvelous job in this respect.

However, the serious problem that confronts us is precisely this: You have brought it out, I think rather emphatically. I have pointed out the fact that we here in this country are not beset with the problem of a shortage of conventional fuels.

Not only that, we are keeping abreast with the amount of electric power that we need in the gradual process of the development our our economy.

However, one of the stated purposes of the atomic energy lay was that this field was to be developed in order to promote world peace. It was consonant with that expressed philosophy that I think the President spoke before the United Nations in December of 1953, when he suggested this international agency.

It was consonant with that idea when he dedicated for international use 20,200 kilograms of U–235 and 20,000 for use in this country.

Naturally there are certain limitations upon your stockholders as to how much money can be placed in this research. You cannot afford to place in the research any more money than you can charge off as an operating expense along the lines that is supervised and is even more or less authorized by the local governing body of public utility commissions, because, after all, they are very much interested in how much money you put in development of this art that might reflect itself in a higher rate in the avent that this field does not progress as fast as some of us would like to have it progress.

With that as a background, do you not think that there is a wide question here as to whether or not we are having adequate participation in the development of this art consistent with the expressed philosophy of the law, consistent with the expressed desire of the President on an international agency, and consistent with the expressed position of leadership that we occupy in the world that internationally we shall not be outrifled in this particular field.

That is a serious question. It is not that we are being critical of private industry. We as the Members of the Congress representing all the phases of our economy must recognize the fact that there has to be an adequate effort here; that that effort might go beyond the bounds of the limitations which are imposed upon certain stockholders that we must recognize, and the question before us here is not that we want to push industry out of this field.

I understand that Senator Gore's bill was to have a supplemental program under the spirit of section 104, and I think I would like to

go into that a little later on as this develops, because people are beginning to look at this as a socialized program of the Government of the United States beginning to monopolize the field of producing electric power through nuclear fission and then selling this steam, or selling this heat to all the distributing companies of the country.

I do not think that is Senator Gore's idea. I think that Senator Gore envisages the six reactors under the spirit of section 104 of the atomic energy law, not section 103, of the atomic energy law.

What have you to say on the subject that I have raised just now; if you want me to be specific on the question, I will ask a specific question.

Mr. FAIRMAN. I think in part I answer you in the general part of my statement.

Senator PASTORE. If you do, I will wait for it.

Mr. FAIRMAN. Perhaps that would point it up a little better if that is agreeable to you, sir.

Shall I proceed?

Senator PASTORE. Yes, you proceed, then.

Mr. FAIRMAN. There have been assertions over the past year that for various reasons industry has been holding back. It has been said, for example, that industry is not obtaining enough information from the Commission.

So far as our company is concerned, we have thus far been able to obtain any information we needed upon request.

Other assertions involve problems of insurance, financing, taxation, and regulation. We are not disturbed about these problems. We have not encountered any substantial financial, regulatory, or tax obstacles to date.

So far as insurance is concerned, we are confident that this problem will be solved before our reactor goes into operation. We hope it will be settled at this session of Congress.

Some have also asserted that industry fears the consequences of application of thermonuclear energy utilizing the fusion process. We have no such fear.

We are satisfied on the basis of the statements made by responsible officials that the usefulness of our plant will not be affected by this new development.

In short, we have no reason to be disappointed at our progress to date, and no reason to believe that the rate of progress will not continue.

And now I should like to turn briefly to the question of the need for the legislation you are now considering.

Despite the incompleteness of my information on some of the factors involved, I believe that I am aware of the basic questions you will examine in reaching a decision on this legislation.

You will certainly want to know whether private industry is holding back. If we in industry convince you that we are not holding back, you will wish to note at that point that every type of reactor which the Commission considered worthy of extensive Government research in its original 5-year program is now authorized or proposed as a construction project.

You will then have to decide whether any useful purpose will be served by the reactor construction contemplated by the Gore bill.

If the purpose is to incorporate new reactor concepts, you will undoubtedly inquire whether the construction of additional power reac-

tors will meet that objective, or whether it would not be preferable instead to expand the Commission's research program.

If tax dollars are to be used most effectively to further our national interests, you may conclude that substantial amounts can be better used on atomic energy for ship propulsion, for example, than on stationary powerplants.

If, on the other hand, the purpose of Government reactor construction is to duplicate the reactor types to be constructed by private industry, I feel certain you will wish to conduct a very searching inquiry into the need for this duplication. Will it, for example, accelerate or delay the projects already underway?

In our opinion, it will delay them because it will spread too thin a limited supply of manpower, materials, and effort.

A more fundamental question is whether a new Government program can in any event accelerate the pace of reactor development. In our opinion, it cannot.

The pace of development is governed not by numbers of men or dollars, but, rather, by the simple fact that the steps in perfecting this new technology must be taken in a certain sequence and with a certain time lag if the results are to be successful.

In listing these questions, Mr. Chairman, I have tried to avoid any basic philosophical overtones. Obviously, as a person connected with private industry, I believe that the job of reactor construction should be carried out by industry and that the Government should step in only if industry does not carry through.

In any event, I hope and believe that the issues involved will be examined in an objective and dispassionate manner by this committee. Certainly, by enacting the Atomic Energy Act of 1954, this committee and the Congress gave the green light to private industry. Industry started from the intersection as soon as the light changed. It is moving, I think, as fast as the speed controls of technology and safety will allow.

And now, Mr. Chairman, I would like to turn from generalities to specific, perhaps after having answered some questions.

With your permission, I should like to ask Mr. Milne to discuss the details of our site plan; the general characteristics of our reactor; its relationship to its allied electric generating plant, and to our system generally; the status of our regulatory and other relationships with the Atomic Energy Commission; our anticipated schedule of expenditures, and the economics of our plant.

Finally, Mr. Landis, of Babcock & Wilcox, will explain the significant design characteristics of our reactor, and the nature and schedule of the developmental, experimental, and fabrication work on the reactor.

Senator PASTORE. Before we get to your associates, I think there are some questions that we would like to ask of you, sir, and I now suggest that Mr. Gore ask any questions that he would like to.

Senator GORE. I would like first to make a statement to you, Mr. Fairman. I think you have presented a challenging statement and from your point of view, it certainly seems to be a fair statement.

I wish you to know that at no time during this hearing or during the debate on the floor of the Senate have I been critical of the slowness of private industry in this field. I have sympathy with the problems

which you face, and with the great risk which your company is undertaking here.

I have said, and repeat to you, that were I on the board of directors of your company or another, I would want to be cautious and careful, and perhaps reluctant, to vote to spend $100 million of stockholders' funds on a project that has at this point little opportunity of being profitable.

After all, there is a limit to which your company or any other company can go in the expenditure of your own stockholders funds on an unprofitable venture. That is proper. I am not critical about that. The position I have taken overall is that whereas the stockholders of your individual company could not afford to launch on a wide-scale development in this field, I feel that the whole people can afford it and indeed, cannot afford to fail to undertake to do so for the reasons cited by Senator Pastore.

I wish to join in the congratulations which Senator Pastore extended to you upon the vigor with which your company is moving into this field. There is, however, a vast field that is being virtually untouched.

As has been pointed out in the hearing, most of the reactors under discussion in our country are based upon water-type reactors. There are other types of reactors which hold great promise. Indeed, it may be through the development of one of the other type reactors that we finally break the economic barrier to the production and generation of competitive power within our own country.

I do not wish to extend this. Before asking a question, I wanted to let you know the objective I had in mind. From my studies, from the information that has been available to me, I come to the conclusion that a primary objective of the Soviet Union is to excel the United States in peacetime uses of the atomic.

Of course we, as you know, are the one nation that has used it for destruction. I think we have a moral obligation, and I believe that sentiment is shared by many people in Congress and by many Americans, to be foremost in bringing the peacetime benefits of the atom to the humanity of the world.

If you were a Member of the United States Senate and felt that way about it, would you be satisfied or would you think that the present program is adequate to maintain our lead in the face of the knowledge we have of the vast developments underway in Russia?

I am not asking you now as the president of a utility company. I am asking you as an American citizen. I will leave out the hypothesis "if you were a Member of the Senate." Maybe you will never be plagued with that position. Just as an American citizen and a responsible one, which I know you are, what would be your reaction to that set of circumstances?

Mr. FAIRMAN. Senator, I have given that some thought as a citizen. It seems to me that in our race with Russia, which takes place on many fronts, we may not be adopting the best methods. I get the impression, too frequently, that they think of something first and then we try to catch up with them, which to me seems to be terrible psychology on the part of the world we are trying to influence.

I believe that we can win this race on quality rather than quantity, for instance, and from what I know, I believe we are well on our way to doing it. I think the Russians are trying to propagandize the world

simply by sheer quantity, numbers, men. They have more of this and more of that.

We can't compete in numbers. We have to compete in quality, which suggests to me that instead of trying to build quickly X million kilowatts of reactors, we should use our dollars in fundamental research in the development of pilot reactors of promising types, and as soon as they are ready to be developed in larger sizes, go ahead and do it.

Of course, we studied this intensively over a year ago. We made our decision to pick this particular type reactor. To a degree, our hands are tied. We are in a metropolitan area or close to it. We had to be sure that what we went in for was safe. That is why we chose a proven technique.

Our one contribution, we think, to the advancement of the art is the use of thorium, which at the time there was considerable interest in, but so far as we could know, little work had been done. We studied a great many other types of reactors. We picked this one because we thought we could make a modest contribution in this field by advancing the knowledge of the use of thorium, which we have hopes, incidentally, to make this thing economic in our area before we are through with it, not the first year, maybe not the fifth year, but we believe this particular construction we have can compete successfully with conventional fuels.

So we are not pessimistic on that. Maybe if we were making the decision today and studied the matter exhaustively we would pick differently, but we understood the object of the change in the law and the purpose of Congress was to get something done, and we felt we were big enough to contribute to that effort and to start last year and put everything we could in it and not divert from our original decision by debating whether something else might be better as of now, but go right down that path and see what we could do.

Senator GORE. Will you yield there now?

Mr. FAIRMAN. Yes, sir.

Senator GORE. You have just arrived at a critical point. You have just stated a critical point so far as I and some other members of this committee see it. You have said that if you were beginning de novo, you might select some other type, which, perhaps at the moment, appears more promising.

That is what has been neglected in the program, and the Atomic Energy Commission, under the present program, is powerless to bring about the development of these other types, either more or less promising, except that the Commission must respond and can only respond to a proposal that is made to it by a private concern.

Obviously, there is a limit to the number of different types of atomic reactors on which your company or any other company can experiment. It would seem to me that it would be vastly beneficial to your industry if the Government itself, representing the whole people, whose national interest is involved in maintaining American leadership in this field, would proceed to develop some of these other more promising types or equally promising types.

Who can tell which one will be the most successful? Then when the Government has demonstrated the feasibility and the economic justification for a particular type or types, it would be available

to your company and the industry of which your company is a part.

Mr. FAIRMAN. May I comment on that, sir?

Senator GORE. Yes, indeed.

Mr. FAIRMAN. First, let me say I am not a nuclear expert. I rely upon others to tell me. I am not aware from what I have been able to read and hear that there is ready for development a reactor of 100,000 kilowatts or something like that, which I take it is the purpose of your bill.

Let me divert and say we agree thoroughly no one knows the answer yet on what is the ultimate type of reactor, and indeed the type most suitable to a particular place may vary. They will depend upon the facility for getting the parts of the machinery there, fuel delivery, processing. These package plants have their place in the scheme of things. They may not be competitive in the sense that I think of it, even the large sizes.

On the other hand, one that is competitive in the sense I take it that you and I are thinking might not adapt itself to a package for some remote location.

Senator GORE. Couldn't we agree further that what might be economic and profitable and useful as a power producer in this country would very likely not be suitable at all to the export program?

Mr. FAIRMAN. That could be.

Senator GORE. And the small reactor of the 10,000 kilowatt order or 20,000 kilowatt order which would be uneconomic as a power producer in your area might very well be wonderful for export to the Middle East.

Mr. FAIRMAN. That could be.

Senator GORE. Because there the economics of power production are vastly different from here. The need for power, the demand for power, the use of power, is much smaller than here, so it would seem to me that in our program our domestic developmental phase should be of one order, whereas our export policy, hopes of export policy, should be of another.

Incidentally, I have seen governmental estimates that the potentiality for export of a reactor and reactor fuels to Western Europe alone in the next decade and a half runs to many billions of dollars. The coal supply in Western Europe is becoming depleted. The dependence upon oil from the Middle East is precarious. The most promising and, in fact, about the only alternative for vast energy source is nuclear power.

In the development of our program for economical competition in international affairs, it seems to me that we should concentrate on perhaps smaller reactors, but certainly here at home, and maybe by building these large reactors here at home we might break the barriers and some bottlenecks and learn how to make even the smaller reactors more efficient.

Mr. FAIRMAN. I agree it works both ways. You learn from very little ones and vice versa. Anything that is learned in this field will complement what the other fellow is doing in his particular problem.

It seems to me, if I understand you correctly, that you make a distinction between the domestic problem and the foreign problem. I am a little bit puzzled as to whether the purpose of your bill is to serve both purposes equally, or the international situation primarily.

If as you suggest, our problem economically is different and we need to study that, of course, it sems to me that we might make progress slowly to advantage. On the other hand, I think I would agree if we are trying to influence the rest of the world we ought to have something, and I think we have it now, that could be given to them.

I don't mean given in the literal sense, but could be sent to them, sold to them, loaned to them, to solve their particular problem which is much more acute than ours is.

Senator PASTORE. Mr. Fairman, did you conclude?

Mr. FAIRMAN. I was just going to come back and say that it seems to me in solving our own domestic problem we are making excellent progress, and there is not much point in spending a lot of money quickly to try to do something that looks big in terms of kilowatts unless we are sure in every step of the way that the fundamental research has been done which makes it advisable to take those steps.

I am confident that if it is known that there is a type of reactor that ought to be built now that isn't on the books, if that was brought to the attention of the industry, somebody would rise and say "That's mine." I don't know of any such. I may not know everything there is to know.

Senator PASTORE. Mr. Fairman, are you familiar with the Gore bill, that is, S. 2725? You may consult with your attorney if you want to.

I have a copy of it here. I want to ask you a few questions because a rather nebulous atmosphere hovers over the function of this committee, I think, by either misunderstanding or interpretation of the bill itself.

Is your fear, or the fear of private industry, as you understand it, principally predicated upon the ground that this bill would tend toward a nationalization of the electric power generation in this country?

Mr. FAIRMAN. I can't speak for the industry on that, sir, but that is not my feeling.

Senator PASTORE. Do you see this bill meaning anything more than reaching a practicability of this art under section 104 of the act, or do you think it goes beyond that because in line 18, of page 2, it says "by section 103 of the Atomic Energy Act of 1954"?

I want to make my position clear on this subject. I am certainly not for the nationalization of the electric power generating industry of this country, and if the Gore bill intends to do that, I think one of the biggest hassles in the country will be where the six reactors are going to go, and this bill will never pass because I don't think they will ever decide where the are going to go.

Personally, I would like to see one go to New England if it is ever going to be, because the cost of electricity is going to be pretty high, but it will resolve itself in a political question as to where these things are going to go.

Certainly, I don't think the atomic energy ought to be used as a substitute for hydroelectric projects, because there we get into the fresh, natural, natural resources of the country, as against this which will only be a substitute for the use of conventional fuels.

I have always felt and I think I should say this as a predicate to the question that I am going to ask you, that if the Gore bill is

confined solely and strictly to the development of the art, until we reach the stage that is recited in section 104 of the 1954 law, reaching the practicability of the use of reactors for the generation of power, then I seriously say that I think that industry is overfretful of Government's participation in this research field, because I would say it is a great boon even to private industry, which has certain limitations upon it in using the proper money, the proper amount of money which might be necessary to build these various reactors, and I have the impression there that I gathered only yesterday from Dr. Zinn who seriously feels and he can deny or refute me if he desires, that unless you get to the building of a large-scale reactor, whether private industry does it or Government does it, you certainly won't perfect the art as speedily as you desire because if you keep it on a small scale, you are really not going to get at the real problems that you must meet, unless you build these large reactors.

Of course, if industry sees the building of these large reactors by Government and then stepping into the field of producing heat and steam and then selling it to private distributing companies, I can see the fear on the part of private industry saying, "Now this is the toe in the door to nationalize this entire industry," and I wouldn't blame private industry if it came in and resisted a bill of that kind before the Congress of the United States decided the policy of whether or not the electrical power industry should be nationalized in this country the way it is in England, and the way it is regimented in Russia.

However, if the Gore bill were clarified merely to better express the development of the art under section 104 of the act, meaning that when the Government got to the point of establishing the practicability of these reactors, then it would have to disengage itself because it is no longer research.

Would you then feel that participation on the part of Government would be an encroachment upon what industry is attempting to do at this juncture in this particular field? If you think my question is loaded, I will break it down for you.

Mr. FAIRMAN. No; I will attempt to answer it, sir.

Senator PASTORE. I tried to make it as clear as I could.

Mr. FAIRMAN. I think my answer would be yes, and I would like to explain that. It is amply evident, I think, from previous testimony that there are many people in the industry who have the fears that you have expressed, that they might have.

My concern when I read this bill which sets a mandatory number of six and presumably large reactors is based upon my experience here in Washington in 1951 and 1952 when I tried to get material and facilities for the power systems of this country both public and private in competition with all the other claimant agencies during that period of emergency, among whom was the Atomic Energy Commission, and the Atomic Energy Commission was the most formidable opponent that the rest of us had.

They got everything they wanted, and I won't say that wasn't right, but it upset schedules of manufacture, it upset deliveries, it just generally raised the dickens.

I can see, assuming that 6 reactors are approved by Congress, 6 large reactors with all the enthusiasm of your committee and Congress behind it, the Commission is going to start to do something, and I

can very well visualize that even with the present capacity, manufacturing capacity, manpower, scientific brains, that something is going to slip and I just have a hunch that it is my reactor and the other private reactors that are going to take second place in that break, and I don't believe the net result of it is going to be that you are going to have more reactors and more kilowatts and more successful demonstration of practicability than we would have if we let this thing go the way it is.

Now, if the Commission has a type of reactor that needs development and nobody has come forward to bid for it, no one could object, it seems to me, if the Government directs the Commission to build that reactor in whatever size is appropriate to demonstrate it, but I am certainly not aware that there are six new types that are worthy of immediate development, and I am not even sure there is one.

Senator PASTORE. I would like to turn this over to Dr. Zinn. Are there questions you would like to ask on this point, Doctor? You are the expert on the reactors. Let's have it, Doctor.

Dr. ZINN. I don't want to repeat testimony which I have been asked to give before, but I would perhaps say this much: That you must confess that the 5-year demonstration program as it was set up 5 years ago did not represent a considered judgment on the part of the Commission that that was all in the way of reactor types that could be profitably exploited at that time.

What it was, was an identification of types then under development in Commission laboratories, and labeling of them as the 5-year program. I think if you look at the whole group of reactor types you will see there are precisely those that the technicians in the Government laboratory happen to at that time have chosen as the ones to be working on, not as the ones which among all possible ones should be then exploited for commercial development.

I am very familiar with the atmosphere in which this was done. Actually, the change in the act was an aftereffect thing. Those reactors, the five that you have mentioned in the demonstration program, were being worked on without having in mind that the Atomic Energy Act would be revised permitting a large-scale commercial development of atomic power in this country.

It isn't even true, I believe, that each one of them is actually under construction. The most notorious one which isn't under large-scale construction is the homogeneous one, which in your testimony is correctly stated, is proposed for construction. I think one has to make a distinction between what you are doing in the case of pressurized water reactors where you really are taking active steps toward construction and a proposal which might lead to construction. I did testify last week that I thought the large-scale experience that we have at Hanford and at Savannah River could conceivably be adapted to power reactors.

This was not in the original 5-year program because it was felt that those reactors were pretty well developed, that the original 5-year program had to do with more or less developed types and they are the ones which were chosen by industry to go ahead on, on perfectly sound grounds, namely, if you make an analysis of the economic situation as you think it might be, you have some hope that the ones you have chosen are going to be the best.

It is only a hope, though, and you have to admit that the economic analysis has enough leeway in it as between one type and another that you could be wrong. So I believe there we have three types I just mentioned which are not new, really, under construction.

Mr. FAIRMAN. What were these three types, Doctor?

Dr. ZINN. There is the Hanford type, which is a graphite pressurized-tube type. There is the Savannah River type, which is a heavy water moderated type. By the way, for heavy water moderated reactors, there are a fair number of variations possible, and, of course, the great attractiveness there is that they might ultimately lead to natural uranium reactors where there might even be an economic advantage in our own country, certainly for export there is, and then finally, in the area of high temperature reactors, I think our program doesn't cover all bets.

We have the sodium graphite reactor being developed only in one model, and yet I think as a powerplant engineer, you would agree that high temperature done on the farther distance might be because the greater cycle efficiency is the path to the cheapest power.

In addition, it is obvious that gas cooling with various types of moderation can also lead to high-temperature operation with high-cycle efficiency, and that isn't being done at all in this country. So when you say you know of no types which have been selected, I think what you are saying is that properly you have made your first choice and are working on them, but there were second choices.

I am sure in your studies that you passed over some types and said, "Well, they are not quite as good," which may not now be under construction.

Mr. FAIRMAN. May I comment?

Senator PASTORE. Yes, go ahead, sir. This is the best way to get it, around the table.

Mr. FAIRMAN. We explored rather exhaustively the Hanford type and rejected it as of that time. I don't know what I would say today, but I suspect the answer would be the same, because of its cost and the fact that it was not as safe to be located in the territories such as ours.

The Savannah River type at the time we were considering this stuff was top secret. Nobody could talk with us. At least we couldn't find out anything about it. Perhaps we missed a bet.

The gas problem, it seems to me, is being pretty well done in England. Why do we duplicate that if they are doing a good job? I assume that they are doing a good job. There is no question about your point on high temperature, sir, but there is a lot of work to be done yet so far as we know in the metallurgical fields or the ceramics fields before you can get something that will take those high temperatures under radiation.

We are all for it. We agree that that is probably the hope. We have to have higher temperature, but first you have to have materials and I should like to ask if it isn't putting you on the spot, do you know any materials that can go to higher temperatures that we can eventually use that we do not now use in thermal practice?

Dr. ZINN. I will answer your question very quickly by asking you what temperature you propose to go to, a temperature and measure of steam in your plant?

Mr. FAIRMAN. In the reactor plant?

Dr. ZINN. The one that you are developing for Indian Point.

Mr. FAIRMAN. It is around 400 pounds. The temperature as it comes out of the reactor, we boost it to 1,000.

Dr. ZINN. But the reactor reproduces 400 pounds, which is very low-temperature steam. Your modern practice would be in the neighborhood of 1,800-pound steam.

Mr. FAIRMAN. We have gone to 2,400.

Dr. ZINN. The limitation on your nuclear plant is because you are using water in your primary cooling.

Hr. FAIRMAN. Yes.

Dr. ZINN. There are development problems in connection with putting fuel elements in hot water, very considerable ones, metallurgical ones.

Mr. FAIRMAN. Yes.

Dr. ZINN. Babcock & Wilcox and your company are spending quite a bit of money in developing these.

Mr. FAIRMAN. That is right.

Dr. ZINN. Why shouldn't someone else spend money to develop high-temperature fuel elements not using water?

Mr. FAIRMAN. I am thoroughly in favor of it, but I don't believe you are ready to build the reactor yet until you have done that fundamental research.

Dr. ZINN. Was the fuel element developed at the time you chose the water-reactor type that you are working on? Was there a fuel element?

Mr. LANDIS. No, sir; there was no fuel element, if I may add a word here. We do have some considerable information, however, on the corrosion of Zira cloy-2 by hot water.

Dr. ZINN. Yes, I know very well you do. I know where you got it.

Mr. FAIRMAN. You developed it.

Dr. ZINN. Mr. Chairman, if I may, I would like to ask Mr. Fairman about another point which he touched on, and which I think is extremely important.

Mr. Fairman, you did comment that you chose your particular reactor because it was safe. That means you made a safety analysis of reactor types. I assume that you in your choice did put into it the fact that one can come up with answers that some reactor might have advantages in connection with safety over others.

Do you say that you picked the safest reactor? That's the one you picked? Of all those you considered?

Mr. FAIRMAN. I wouldn't go that far, sir.

Dr. ZINN. Because if you did, I would have to say that I think it is very difficult to decide that one reactor is safer than another. I think this is a very difficult technical judgment, but if I had to make such a judgment, I wouldn't agree with you if you said that you had picked the safest one.

I couldn't go along with that. So you cannot use, I believe, just categorically safety as the reason why you preferred one type over another, and then discarded another one. I don't believe you can without going into a very large amount of technical information.

Mr. FAIRMAN. Not as the sole criteria, no.

Dr. ZINN. I could pursue that one further, and perhaps point out that there isn't really anything else but judgment to go on in the safety business; isn't that right?

Mr. FAIRMAN. Yes.

Mr. LANDIS. I thing we ought to second that, because I believe that when you come right down to analyzing the reactor-evaluation steps we went through, it was just a matter of judgment in choosing between, say, the pressurized water reactor, which has a negative temperature coefficient, and the graphite moderated pressurized water-cooled reactor, which perhaps has a positive temperature coefficient.

Dr. ZINN. Of course, it can be designed with a negative one.

Mr. LANDIS. It can, yes. At that time we had a very lazy conception of that reactor. I think we ought to confess that, but we did the best we could in the time allowed.

Dr. ZINN. Perhaps as a last word on this, of course, you know that the British favor their type of reactor because they believe it has a degree of safety somewhat greater than you can get in any water-cooled reactor.

Mr. FAIRMAN. Yes.

Mr. LANDIS. Which is correct.

Dr. ZINN. It is their stated reason. It is only corerct if you keep the rating of the reactor low, which they do, which doesn't lead to the best economic picture.

Senator PASTORE. To repeat again, of course, we are all refreshed and elated over the fine effort that Consolidated Edison Co. is making in this particular field because I understand they are going it exclusively on their own money. They are not asking for any subsidy at all from the Government, which is a fine demonstration of good citizenship and fine participation on the part of private industry in the development of this art.

Senator GORE. And commendable risk.

Dr. ZINN. That is right.

Senator PASTORE. But just as has been brought out here in this short colloquy between these two experts, it points up pretty much that there are some of these calculated risks so strong and so big we wonder whether private industry can actually undertake it.

We realize private industry has dedicated maybee $200 or $300 million to this effort, but we question whether that is quite enough; whether or not there ought to be some participation on the part of the Government, not to get into the electric power business, but whether they should get into the building of these full-scale reactors for research purposes, so we can develop at least the practicability of the art, and that is the question that disturbs me.

I think that is the question that disturbs a lot of the members of the committee and a lot of the Members of the Congress, and that is the question we have to decide, not to kind of push you out of the way, or to impede your effort, because if we are going to step on anybody's toes, we ought to stay out of it.

On the other hand, if we can help and augment the program or supplement that program, I question whether or not it wouldn't also be a boon to private industry to have Government money go into this, too, to a larger extent in order to bring about the day in quicker fashion when we are going to have competitively speaking electric power manufactured by nuclear fuels.

That is the simple problem and without nationalization, without socialization, without the Government stepping into this field of manufacturing and selling electric current, which I hope no one on this committee envisions for the time being, because I don't want to see that industry nationalized.

Mr. FAIRMAN. If I may answer the implied question, sir, I hope I have made it clear that we certainly are not opposed to fundamental research in this field, nor I think would we be opposed if the time arrives when the experts in the Commission say, "Here is a type of reactor that ought to be explored." If nobody will come forward and do it, then certainly I would not object to the Commission building one for demonstration research purposes, but I don't believe that time has arrived, and I don't believe it has been tested.

Senator PASTORE. I respect your judgment in the matter, Mr. Fairman. Of course, there may be others who might disagree with you and that is the question we have to decide, but at any rate, you ought to be complimented and congratulated for the fine work you have done thus far. I think we hadn't ought to escape the opportunity of saying that again and again and again, because it serves as an example and inspiration to other private industry to join hands together and do as you have done.

Mr. FAIRMAN. Would you like now, sir, to have a brief——

Senator PASTORE. Yes. We ought to introduce your papers in there entirely for the record, and then, of course, any comments that your experts would like to make.

Just identify yourself on the record and give us a résumé.

Senator GORE. May I make a brief comment off the record?

(Discussion off the record.)

Mr. FAIRMAN. Mr. Milne.

Senator PASTORE. Identify yourself, please, sir.

STATEMENT OF GORDON R. MILNE, ENGINEER, CONSOLIDATED EDISON CO.

Mr. MILNE. My name is Gordon R. Milne. As the mechanical engineer for the Consolidated Edison Company of New York, I am in charge of the structural and mechanical planning and design of electric, gas, and steam production plants for that company. I have served in various capacities with Consolidated Edison and its predecessor companies since 1921.

I am a registered professional engineer and received the degree of mechanical engineer from Stevens Institute of Technology.

Site conditions: For the Indian Point nuclear powerplant the company purchased approximately 350 acres of land on the east bank of the Hudson River at Indian Point in the village of Buchanan in upper Westchester County, N. Y., at a cost of about $300,000.

The site is on a wooded and rocky promontory of land about 24 miles north of New York City. Its relative location in the area and also with respect to the rest of the Consolidated Edison system can best be shown by reference to plate 1, which indicates that this plant will be connected to the high voltage transmission interconnections now existing between the Consolidated Edison system and the Niagara Mohawk system to the north.

In the selection of a site for a nuclear powerplant the property must have favorable characteristics with respect to seismology, geology, hydrology, and meteorology, as well as suitability from more conventional standpoints.

The report on the seismic characteristics of the area has been prepared by Fordham University since they possessed the seismograph and seismic records.

The report of Father Lynch, head of Fordham's seismic laboratory, that this area had never had a severe disturbance and that it has been and should continue to be as free of earthquakes as any known area in the world, was reviewed and concurred in by Capt. Eliott Roberts, head of the Geophysics Division of the United States Coast and Geodetic Survey.

A report on the geology of the site has been rendered by Sidney Paige, who until retirement was professor of geology at Columbia University, and a consultant on many large construction projects. The conclusion in his report is that the rock existing at this site, properly grouted, would support any structure that man might build.

The hydrology of the area has been investigated by Carl Kennison, a consulting engineer and also the chief engineer of the New York Board of Water Supply. His report stated that with safety features of the plant design as disclosed to him, there appears no possibility of radiocontamination of the Hudson River or of the public water supplies in the area.

In April 1955, the company entered into a contract with New York University to investigate and report on the meteorological conditions in the area.

Because of the time required to acquire the extensive instrumentation needed at the site, and in adjacent areas, and to erect a high instrumentation tower on the premises, the collection of some of the data will not be completed until the early part of 1957.

Reports on the above formed part of the data submitted during 1955 to the Atomic Energy Commission and its Advisory Committee on Reactor Safeguards.

PLANT CHARACTERISTICS

The nuclear reactor for this project will be a pressurized water arrangement using uranium as base fuel and thorium as the fertile material. We believe that the use of thorium represents a considerable advance toward making nuclear power ultimately less expensive than that obtained from conventional fuels.

Since this is the first application of thorium to a large power reactor, it has been necessary to prepare a number of detailed technical reports during the past year for submission to the Commission.

Since it is desirable on the first reactor of this type to hold the nuclear fuel temperatures to moderate levels, the resulting steam temperatures are correspondingly low in comparison with conventional steam electric generating practice.

Therefore, to effect further economy in the generation of electric power, a separate oil-fired superheater will be installed to superheat the steam produced by the reactor before its utilization in the turbine. The basic concept of this plant arrangement is shown on plate 2.

The heat produced by the reactor would result in electric generation of 140,000 kilowatts capacity. The addition of the oil-fired superheater will yield an additional 96,000 kilowatts of electrical capacity, or a total plant capacity of 236,000 kilowatts.

We have calculated the cost of the Indian Point project before and after the addition of the superheater. Plant cost per kilowatt of electrical output capacity will be reduced to 70 percent of the unit cost of plant capacity which would have resulted if the relatively low temperature saturated steam produced by the reactor were used directly in a turbine.

Consolidated Edison has now in operation 3,700,000 kilowatts of conventional steam electric generating capacity and, together with 750,000 kilowatts of capacity now under construction, will have at least 4,450,000 kilowatts in operation prior to the start of operation of the Indian Point nuclear plant.

Therefore, the nuclear plant will at that time represent about 5.5 percent of the total generating capacity on the Edison system.

The estimated cost of electric power to be generated by the Indian Point plant is shown on plate 3. This cost, including fixed charges at 13.5 percent, fuel costs, cost of reprocessing nuclear fuel, and all operating and maintenance charges, should be about 9 mills per kilowatt-hour. To be conservative we have included in this total a charge of 1 mill for operation and maintenance exclusive of fuel as compared to one-half mill for our newest conventional plant.

Of course, the cost of reprocessing nuclear fuels is at best an approximation since commercial reprocessing plants have yet to be built and operated.

The figure of 9 mills per kilowatt-hour compares with 7½ mills which is the cost of electrical generation in our newest conventional steam plant.

CONTRACT WITH BABCOCK & WILCOX

Our contract with Babcock & Wilcox was made on March 18, 1955. It is a fixed price contract subject to the usual escalation provisions for increases in the cost of labor and materials. We may cancel the contract under certain circumstances, but must in any event pay all costs accrued to the date of cancellation.

RELATIONSHIP WITH THE COMMISSION

With regard to our partiular project our relationship with the Atomic Energy Commission actually began on December 7, 1954. In a letter of that date we told the Commission that we were beginning talks with manufacturers.

After action by our board of trustees and the execution of the contract with Babcock & Wilcox, we filed an application for licenses with the Commission on March 22, 1955. We supplied detailed information in our application although some of our data was tentative at that time and although regulations under the 1954 act had not yet been issued.

The application was amended on August 1, November 22, and December 19, 1955.

The amendments in part resulted from discussions with representatives of the Commission and of the Commission's Advisory Committee on Reactor Safeguards, over a period of several months.

I assume that this committee has been informed of the content of the application and amendments, but we would be happy to file them for your record if you consider it appropriate.

In our original application we applied for a facility license under section 104 (b) of the act; a license for the possession and use of source material; a license for the possession and use of special nuclear material, and a construction permit.

We also requested the Commission to enter into arrangements with us for the supply of material and for reprocessing services.

As you know, we received a construction permit on May 4, 1956. This construction permit incorporates an allocation of special nuclear material over the proposed period of operation of the reactor.

On March 14, 1956, the Commission issued to us a license for 20,500 kilograms of thorium to be used initially in the experimental work being conducted by Babcock & Wilcox. We have not received a license for the possession and use of special nuclear material or for the possession and use of source material for the period of reactor operation, nor have we yet reached any understanding with the Commission regarding reprocessing services.

In addition to the proposal contained in our original application, we sent a letter to the Commission on December 20, 1955, again suggesting that some arrangements with regard to these services be made.

We have not yet filed an application for licenses for the individuals operating the reactor and for the possession and transfer of byproduct material, but we expect to do this in ample time before the reactor goes into operation.

We received an access permit from the Commission on July 7, 1955, and on March 5, 1956, applied for an amendment to that permit to give us information on controlled thermonuclear processes. This was granted on March 22, 1956.

Fuel element procurement fabrication and reprocessing: Although, as I have indicated, we have proposed arrangements with the Commission for the needed supply of thorium and for the performance of reprocessing services, we realize that such arrangements will probably be conditioned on our making arrangements in these matters with private industry as soon as feasible. We have already taken steps in that direction.

In order to secure proposals covering a supply of thorium for the reactor, we have already talked to the following companies: Sylvania Electric Products, Inc., Vitro Corporation of America, Horizons, Inc., National Research Corp., William H. Doxey.

The first four of these companies have expressed an interest in submitting proposals. Meetings have been held to discuss details with Sylvania Electric Products and with the National Research Corp., and we have asked them to submit their proposal by August 1, 1956.

For the initial core the company plans to have the fuel elements fabricated at the new fabrication plant of Babcock & Wilcox at Lynchburg, Va. This is covered in our contract with Babcock & Wilcox.

The company has contacted and will negotiate with Sylvania and Blaw-Knox in combination, with Koppers, with Vitro Corporation of America, and with Union Carbide, to obtain proposals for the reprocessing of spent fuel elements. However, these negotiations have not progressed to the point where a date for the submission of bids can be set.

Schedule: The schedule which we intend to follow for the preparation of specifications for contract bidding, for the procurement of major equipment and for the construction in the field is shown on plate 4, for the nuclear portion of the plant and on plate 5 for the rest of the plant.

In preparing the contract drawings for the field construction of our generating stations, the major equipment such as the superheater and turbine is first purchased and specifications for bids are then issued for the auxiliary equipment properly coordinated with the main units.

Upon receipt of the various equipment drawings from the manufacturers, the foundation and structural drawings can be made. From these drawings contracts can be awarded for the start of field construction.

Specifications for the main turbogenerator which will cost approximately $8 million, and for the superheater which should cost about $2,500,000, have been issued to the manufacturers for bidding, and while our schedule requires that these units be ordered by August 1, 1956, it now appears likely they will be ordered by July 1, 1956.

Similarly, Babcock & Wilcox will proceed to order material for fabrication of the reactor, reactor vessel and boilers which they will manufacture in accordance with the schedule on plate 4.

Thus, by the end of 1956, Consolidated Edison directly, and through its contractor, Babcock & Wilcox, will have expended and committed a total of about $21 million. The remainder of the $55 million, or $34 million, will be spent about uniformly during the years 1957 and 1958 and 1959 on purchase of minor equipment, for materials, and for field construction.

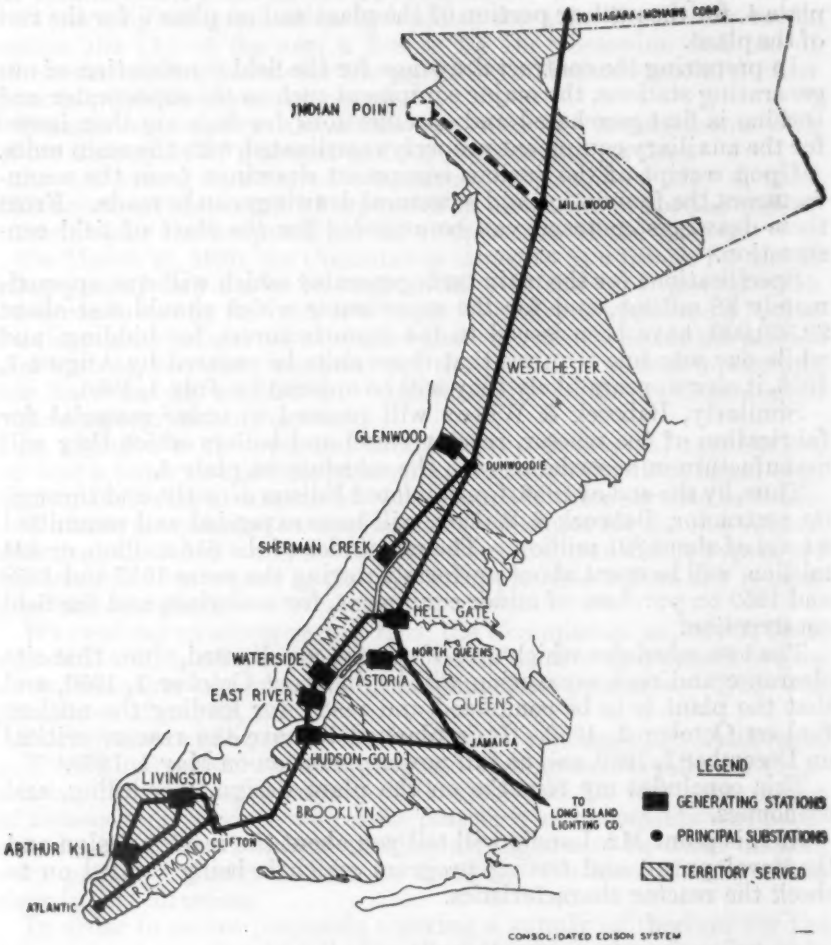
The two schedules which are, of course, coordinated, show that site clearance and rock excavation will begin about October 1, 1956, and that the plant is to be completed and ready for loading the nuclear fuel on October 1, 1959. It is planned to have the reactor critical on December 1, 1959, and at full power operation on May 1, 1960.

This concludes my remarks on the plant design, scheduling, and economics.

At this point Mr. Landis will tell you about the reactor design and the development and testing program which is being carried on to check the reactor characteristics.

(The charts submitted by Mr. Milne follow:)

PLATE I



ELECTRIC GENERATING STATIONS, PRINCIPAL SUBSTATIONS AND TIE FEEDERS

PLATE II

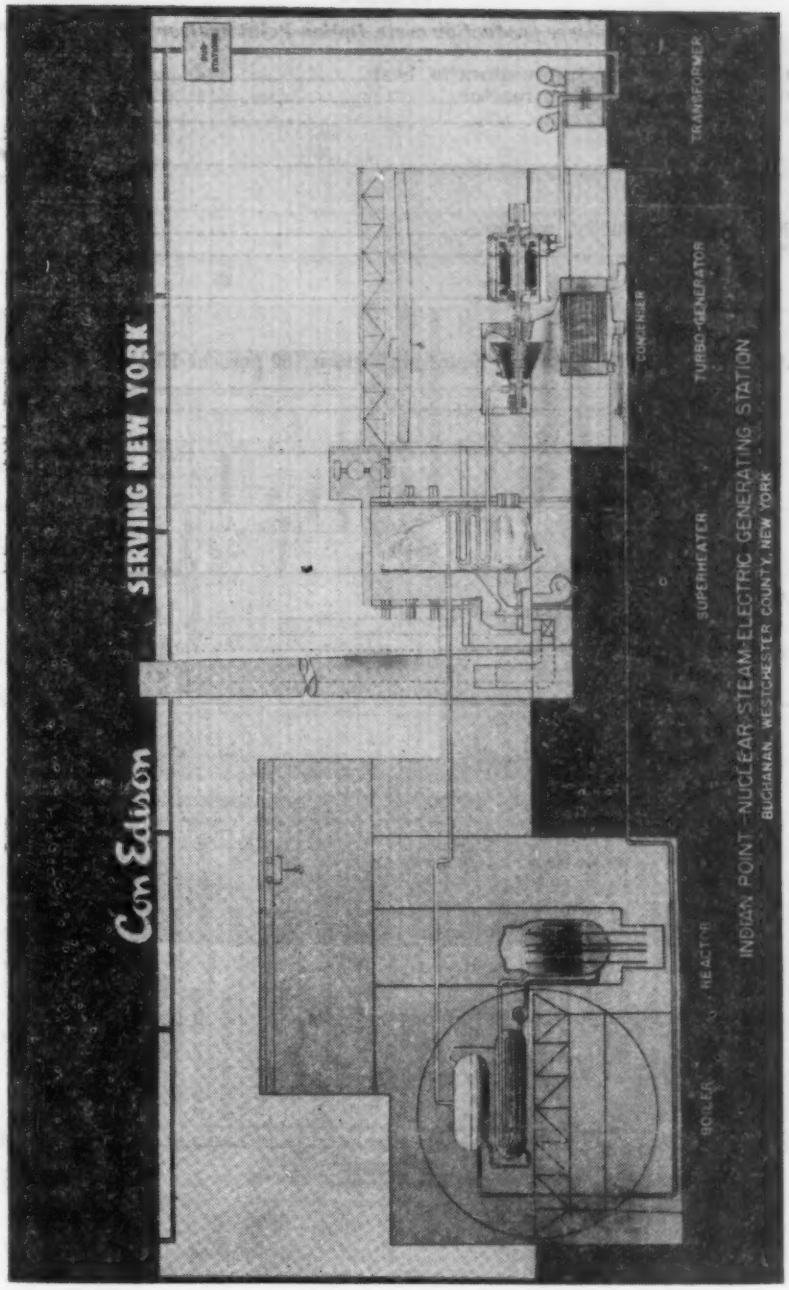

Con Edison
SERVING NEW YORK
AIR PHOTOMAP
CONDENSER
TURBO-GENERATOR
TRANSFORMER
SUPERHEATER
REACTOR
BOILER
INDIAN POINT - NUCLEAR-STEAM-ELECTRIC GENERATING STATION
BUCHANAN, WESTCHESTER COUNTY, NEW YORK

PLATE III

Estimated power production costs, Indian Point nuclear powerplant

Gross reactor capacity, megawatts, heat	500
Gross electric capacity, reactor	140
Superheater	96
Total	236
Net electric capacity, reactor	130
Superheater	89
Total	219
Annual net million megawatt-hours production (80 percent LF):	
Reactor	910
Superheater	623
Total	1,533

	Amount	Cents per kilowatt-hour
Annual costs:		
Fixed charges, 55 million at 13.5 percent	$7,430,000	.485
Fuel, nuclear oil	4,650,000	.303
Operation and maintenance	1,500,000	.100
Total	13,580,000	.888

PLATE IV

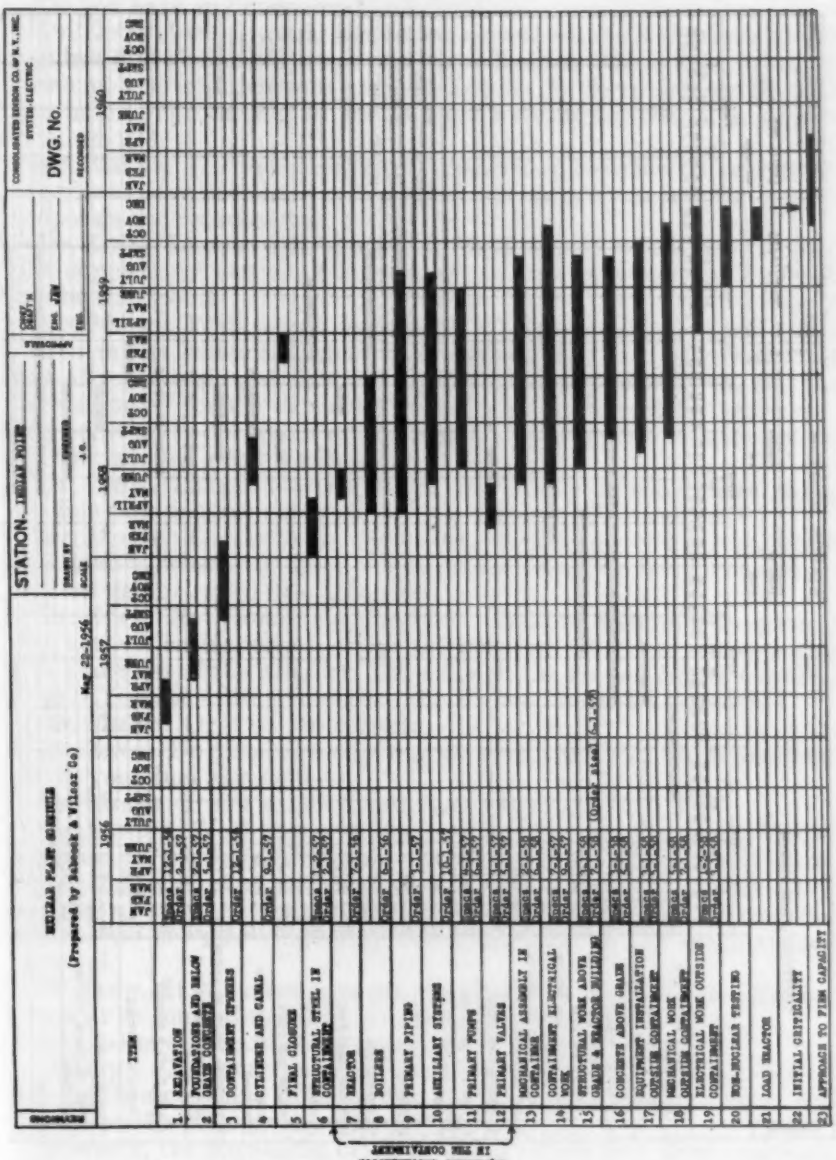
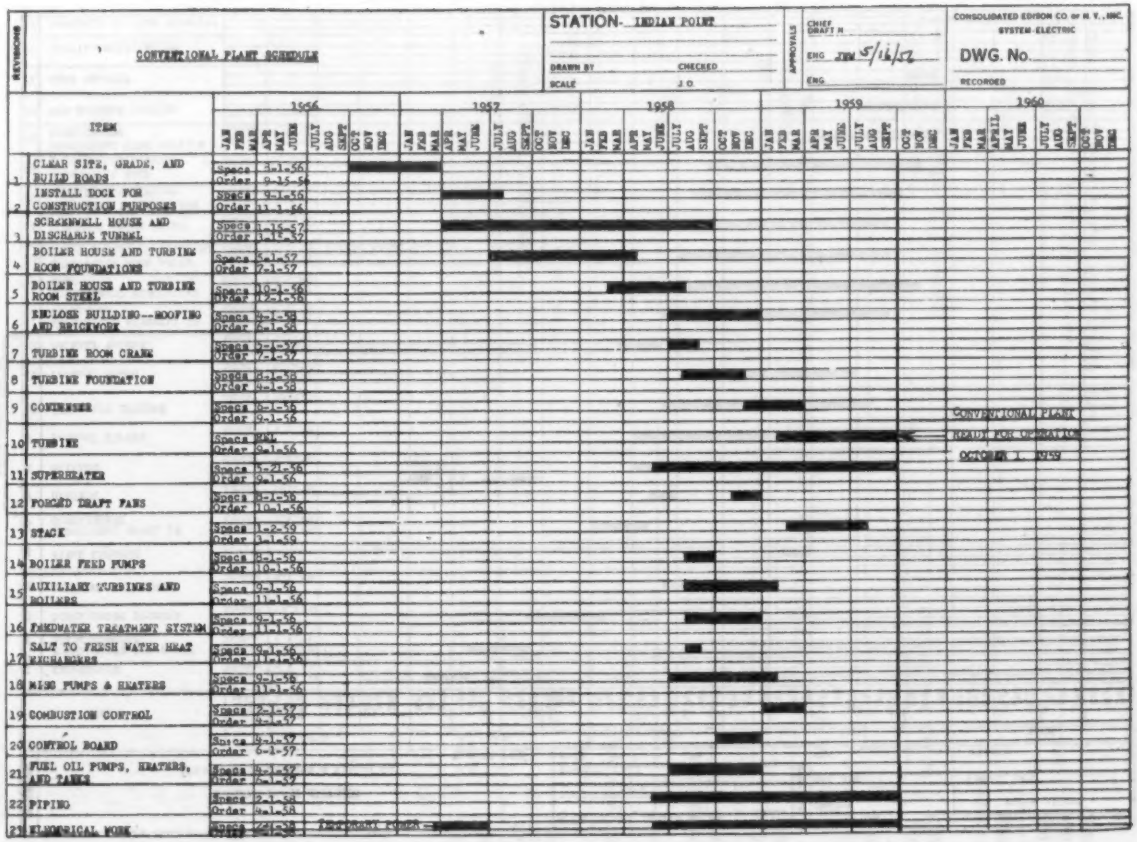

ENGINEERS
MERIAN PLANT SCHEDULE
(Prepared by Babcock & Wilcox Co)
Mar 20-1956
STATION MERIAN POINT
DRAWN BY
SCALE
APPROVED
CONSOLIDATED EDISON CO OF N.Y., INC.
SYSTEM ELECTRIC
DWG. No.
RECORDED
ITEM
1956
1957
1958
1959
1960
RADIOACTIVE INSTALLATION IN THE CONTAINMENT

PLATE V


REVISIONS
CONVENTIONAL PLANT SCHEDULE
STATION- INDIAN POINT
DRAWN BY
CHECKED
SCALE
J.O.
SYNCHRONIZE
CHIEF DRAFT M.
ENG. JJW 5/16/57
ENG.
CONSOLIDATED EDISON CO. OF N. Y., INC.
SYSTEM-ELECTRIC
DWG. No.
RECORDED
ITEM
1956
1957
1958
1959
1960
JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC
1 CLEAR SITE, GRADE, AND BUILD ROADS Space 3-1-56 Order 9-15-56
2 INSTALL DOCK FOR CONSTRUCTION PURPOSES Space 3-1-56 Order 11-1-56
3 SCREENWALL HOUSE AND DISCHARGE TUNNEL Space 11-15-57 Order 1-15-57
4 BOILER HOUSE AND TURBINE ROOM FOUNDATIONS Space 5-1-57 Order 7-1-57
5 BOILER HOUSE AND TURBINE ROOM STEEL Space 10-1-56 Order 12-1-56
6 ENCLOSE BUILDING--ROOFING AND BRICKWORK Space 9-1-58 Order 5-1-58
7 TURBINE ROOM CRANE Space 5-1-57 Order 7-1-57
8 TURBINE FOUNDATION Space 6-1-58 Order 9-1-58
9 CONDENSER Space 8-1-58 Order 9-1-58
10 TURBINE Space [illegible] Order 9-1-58
11 SUPERHEATER Space 5-21-58 Order 9-1-58
12 FORCED DRAFT FANS Space 8-1-58 Order 10-1-58
13 STACK Space 1-2-59 Order 3-1-59
14 BOILER FEED PUMPS Space 8-1-58 Order 10-1-58
15 AUXILIARY TURBINES AND BOILERS Space 9-1-58 Order 11-1-58
16 FEEDWATER TREATMENT SYSTEM Space 9-1-58 Order 11-1-58
17 SALT TO FRESH WATER HEAT EXCHANGERS Space 9-1-58 Order 11-1-58
18 MISC PUMPS & HEATERS Space 9-1-58 Order 11-1-58
19 COMBUSTION CONTROL Space 2-1-57 Order 4-1-57
20 CONTROL BOARD Space 5-1-57 Order 6-1-57
21 FUEL OIL PUMPS, HEATERS, AND TANKS Space 6-1-57 Order 8-1-57
22 PIPING Space 2-1-58 Order 4-1-58
23 ELECTRICAL WORK Space 2-1-58 Order 4-1-58
PRELIMINARY WORK
CONVENTIONAL PLANT READY FOR OPERATION OCTOBER 1 1959

Senator PASTORE. Thank you very much, Mr. Milne.

Do you have any questions?

Dr. ZINN. Yes. I would like to ask a question about thorium which I didn't find the answer to in your cost figures. Of course, in using thorium, you will generate uranium 233 in the fertile material. Do you in the reprocessing of the fuel get a credit for the value of the uranium 233?

Mr. MILNE. We do not as yet, no, because no commercial reprocessing plants have been built or operated and we are just negotiating on proposals for reprocessing.

Dr. ZINN. In your estimate of 9 mills, I believe it says, for the cost of the power, if you don't have a cost of reprocessing, how did you handle that point?

Mr. MILNE. Well, we do have a cost of reprocessing, but as I mentioned in the statement, since these plants have not been built, the cost of reprocessing at this time is at best an approximation, and we have assumed for the moment one-half mill in the cost for reprocessing, and that is purely an estimate and I don't believe anyone knows at this time just what it will be.

Dr. ZINN. That is the net cost to you, assuming somewhere along the line that you have a credit for the uranium 233 produced?

Mr. MILNE. That is right. After the reprocessing with all the debits and credits, what may come in the reprocessing we have assumed to be a net debit to us of one-half mill.

Dr. ZINN. Now comes the question. You are assuming in getting this net, which includes a credit for uranium 233, that someone else will make use of the uranium 233, namely, the United States Government. You are selling it back to the United States Government?

Mr. MILNE. Or it will be reused.

Dr. ZINN. Do you have any way in which you can reuse uranium 233 in your fuel element?

Mr. MILNE. I will let Mr. Landis answer that.

Mr. LANDIS. We do not now have any way that we can use the U–233 generated in these fuel elements because this requires, as you well know, remote fabrication of the new elements. We are trying to work out a method of remote fabrication which will approximate in cost the method we are now employing for fabrication of the original core material.

Dr. ZINN. If you manage to get a method that approximates the cost you will be congratulated by everyone in the business.

Mr. LANDIS. We are going to try, sir.

Dr. ZINN. The purpose of my question, to be perfectly frank, is that thorium is a very fine thing to use, but it is a much finer thing if you can get on the thorium-uranium 233 cycle.

However, the stumbling block in doing this is just what you said, getting a method of fabrication that can be economically successfully.

Mr. LANDIS. Of course, Dr. Zinn, we also hope that by the time the Con-Edison reactor is producing U–233 there may perhaps be some aqueous homogenous reactors in operation or being built which will take the U–233 in solution form.

Dr. ZINN. I think the purpose of my question was merely to establish that the real value of thorium will come only after the recovery and effective use of the generated material is accomplished, which is a rather difficult technical problem.

Mr. LANDIS. That is correct. Although we are basing our estimates on the firm price schedule issued confidentially by the AEC, we realize that there are lots of other factors to be brought into the picture, including the fabrication problems that Dr. Zinn has mentioned.

Senator PASTORE. Mr. Landis, we will have your statement now.

STATEMENT OF JOHN W. LANDIS, THE BABCOCK & WILCOX CO.

Mr. LANDIS. Abstract: The reasons for selection of the pressurized water thorium converter reactor are given. The design work which has been carried out is outlined. The salient features of the design are described. The experimental work underway is summarized.

My name is John W. Landis, and I am assistant manager of the atomic energy division of the Babcock & Wilcox Co.

Before entering the employ of the company in 1953, I was a reactor engineer in the Reactor Development Division of the Atomic Energy Commission for 3 years, and prior to that, proceeding back in time, head of science and engineering test development for the Educational Testing Service, a consultant to the Navy Department in guided missiles, a research fellow at Princeton University, a naval officer, and a research engineer with the Eastman Kodak Co.

You have heard from Mr. Fairman and Mr. Milne concerning the objectives and general status of the Consolidated Edison thorium reactor project. I have been asked to add to the picture by discussing in greater detail the nuclear and steam generation aspects of the project.

First of all, you may be interested in the reasoning which led Babcock & Wilcox to selection of a pressurized water thorium converter reactor for this particular application.

We had been asked for a firm price bid. The only actual experience on which to base such a bid was the submarine thermal reactor. This channeled our thinking to the pressurized water system.

Under our industrial participation program agreement with the Atomic Energy Commission, we made several conceptual design studies of various possible fuel and fertile material arrangements and finally decided that the use of thorium in a uniform distribution throughout the core held out the most hope for efficient operation of this type reactor.

Further, we felt that this innovation would satisfy the Consolidated Edison requirement that the reactor incorporate a significant advance in reactor technology.

To our knowledge, the Consolidated Edison thorium reactor is the only reactor designed or even proposed to date which incorporates internal conversion of thorium.

The advantages of this new fuel arrangement compared with nonconverting uranium cores for a large-scale plant include:

1. Increased flexibility of operation;
2. Potentially lower fuel costs;
3. Greater burnout of the basic fuel and fewer fuel changes;
4. Utilization of a new raw material which may be more plentiful than uranium.

For these and other technical reasons, we believe that operation of a thorium converter reactor will be worthwhile from both the scientific and the economic points of view.

A great deal of work has been put into design of this reactor to date. It totals almost 700 man-months.

And I might insert parenthetically here that this is the total effort after we signed the contract.

At present about 55 technical personnel are assigned to the project full time and about 40 part time. The project group includes theoretical and experimental physicists, nuclear engineers, mathematicans, mechanical engineers, electrical engineers, metallurgists, chemists, chemical engineers, stress analysts, computers, programers and draftsmen.

In addition, the accumulated experience of the other groups in the atomic energy division and of every other division of the company, is available to the project group on a consulting basis.

The company considers the CETR, as we abbreviate this project, to be one of the most important contractual obligations it has ever assumed. No effort will be spared to carry the project to a successful conclusion.

Immediately following acceptance of our proposal and submission of a license application to the AEC, we began an exhaustive analysis of the characteristics of the CETR from the safety standpoint. We met several times with representatives of the Advisory Committee on Reactor Safeguards and in accordance with their advices prepared a series of hazards evaluation reports which were submitted to the Division of Civilian Application late in 1955.

The first such report consisted of a description of the nuclear characteristics of the reactor for both steady state and dynamic conditions and a summary of the associated control rod, shim rod and excess reactivity requirements. Preliminary calculations on various types of credible accidents and on the heat fluxes necessary for thermal failure were also presented.

The second such report was on the basic philosophy of the containment and waste disposal systems. This philosophy was stated in terms of design assumptions and accident sequence.

The third such report was a preliminary analysis of the transients resulting from various operational procedures.

These reports are on file in the public document room of the Division of Civilian Application at 1717 H. Street NW., here in Washington.

The primary conclusion from this hazards evaluation work was that the proposed reactor should offer no problem other than those usually encountered in all heterogeneous pressurized water reactors. In other words, it was concluded that the presence of thorium would not affect the safety of the reactor in a significant way.

A formal hearing before the Advisory Committee on Reactor Safeguards was held on January 4, 1956. On the basis of this hearing and the license information which had been submitted directly to the Division of Civilian Application, a construction permit for the project was issued May 4, 1956.

Several months prior to the formal ACRS hearing we had initiated detail design work with respect to optimization of the core components, the heat balance of the system, the water purification equipment, the pumps, the valves, the control rod drives, the mechanical handling equipment, the pressurizer, and the arrangement of the containment

and fuel element cooling components. This detail design work has been continued with increasing intensity to date and will continue well into 1957.

Perhaps the best way to emphasize how much work has been accomplished on this project is to summarize briefly the salient features of the design as it now stands.

The latest drawing of the reactor steam generator complex of the CETR is shown in figure 1. This equipment, the equipment which Babcock & Wilcox will supply, comprises the reactor proper, the necessary piping and valves, the boilers, the circulating pumps, the pressurizing system, the coolant treatment and makeup system, the fuel element charging and discharging devices, the reactor controls, and associated instrumentation; the safety containment vessels, and the shielding, plus auxiliary and service equipment.

As I have said, the reactor is an internal thorium thermal converter. It is fueled with highly enriched U–235 and thorium and is moderated and cooled with pressurized light water. The active portion of the reactor, the core, is a right cylinder about 6 feet in height and about 6 feet in mean diameter.

The core is housed in a heavy pressure vessel about 23 feet high and 10 feet in diameter with a wall thickness of nearly 6 inches.

The pressure vessel is in turn set in a large containment tank, approximately 50 feet by 20 feet, which is filled with water. The top closure of the pressure vessel is held in place by fifty-eight 3¾-inch studs and is buffer sealed. The top closure of the containment tank is bolted and single gasketed.

The pressure vessel is made of carbon steel clad on the inside with stainless steel. Stainless steel thermal shields protect the main body of the vessel against structural damage and excessive heating from neutron and gamma flux. The containment tank is made of carbon steel.

Stainless steel jacketed insulation is wrapped around the pressure vessel to reduce heat losses during operation. The water in the containment tank acts as a heat sink and a neutron shield.

The core of this reactor is made up of over 100 replaceable fuel elements each of which is square in cross-section and contains alternate fuel and fertile plates separated by coolant channels. The configuration and dimensions of the fuel element are shown in figure 2.

The fuel plates consist of uranium zircaloy "meat" clad with zircaloy, and the fertile plates consist of thorium "meat" clad with zircaloy.

Separation of the fissionable and the fertile material in this manner makes possible relatively lengthy irradiation of the fuel elements before removal is necessitated. This is due in part to the fact that with the passage of time an appreciable portion of the U–233 produced in the thorium is consumed in situ and contributes to the reactivity of the core in a favorable way.

The core is surrounded laterally by a 6-inch water reflector. It is supported and held together by a grid plate at the bottom and a guide plate at the top, both of stainless steel.

The composition of the core is determined by the requirements of heat transfer, structural integrity, and excess reactivity and the need for an adequate negative temperature coefficient.

With about 55 percent of the core volume filled with water and an inventory of about 8,275 kilograms of thorium, approximately 275 kilograms of fully enriched U–235, provide sufficient excess fuel to accommodate the various reactivity changes. With this loading the initial thermal neutron flux at full power is approximately 8 x 10^{13} n/cm^2/sec.

Under normal conditions 120,000 gallons per minute of coolant are passed through this reactor, mostly through the fuel element, coolant channels, but significant diversions are made for the control rods, the reflector, and the thermal shields.

Flow is upward, single pass, from four 20½-inch inlet nozzles in the lower section of the pressure vessel, just below the removable head closure. The pressure is maintained at 1500 p. s. i. a.

This pressure is great enough to prevent boiling at the upper ends of the core coolant channels, where the temperature is highest. The coolant temperature is limited by a maximum fuel plate surface temeprature of 600° F.

Mean reactor outlet temperature is 510° Fahrenheit and mean reactor inlet temperature is 480° Fahrenheit. This is sufficient delta T for generation of the rated heat power.

The average heat flux for full power operation of a new core is about 167,000 Btu per hour-$foot^2$. This is reduced somewhat as the production of heat is spread to the thorium plates, and since no more than one-third of the core will be replaced at any time, will probably never exceed the initial value.

For proper operation of this reactor, an excess of reactivity over the cold, clean core is required in order to compensate the effects of--

1. Increase in moderator (water) temperature;
2. Buildup of equilibrium poisons (Xe–135 and Sm–149);
3. Burnout of fuel and buildup of higher isotopes;

and

4. Short time shutdown buildup of Xe–135.

This excess reactivity is balanced out as required by 19 individually driven cross-shaped boron steel control rods which ride into the reactor from above, but are actuated from below by means of zirconium extension pieces. The drive mechanisms are located in a sealed housing attached to the bottom of the reactor containment vessel. The effective part of each rod assembly is about 5½ feet long.

The proposed rod pattern is a central regulating rod surrounded by 18 shim rods in 2 concentric rings.

The size and location of the rods will be such as to provide the required excess reactivity, plus about 5 percent extra shutdown delta *k* below the cold, clean condition, to provide for suitable sensitivity to regulating rod movement, and to obtain some degree of flux uniformity.

Rod removal rates will be limited to insure a safe maximum rate of reactivity change.

An additional safeguard is provided by the negative temperature coefficient of 1.5 x 10–4 delta *k* per degree F. at operating temperature.

The control rod drives will probably be of the hydraulic type, with scram action initiated by a hydraulic unloading valve. Scram force will be provided by the pressure in the reactor acting on the piston area of the extension shaft. This may be augmented by spring force

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or by a hydraulic accumulator. Snubbers will be required to decelerate the control rod assemblies near the end of the scram stroke.

The primary coolant system consists essentially of four loops operating in parallel, each transferring one-quarter of the total power generated by fission in the reactor core to the steam system. Each loop comprises a boiler, two 15,000 gallons per minute pumps with associated check valves, 24-inch stainless steel pipe, and two 24-inch remotely operated stop valves to permit isolation of the loop.

The auxiliary equipment includes the pressurizer and the water makeup and purification equipment.

The reactor is located at the low point in the system. This permits drainage of a boiler loop without uncovering the core and facilitates natural convection removal of decay heat in the event of pump failure.

The pressurizer is located at the high point of the system. This facilitates venting, filling, and pressure control. Pressure is applied to the system by a steam head in the upper part of the pressurizer. The steam is created by cartridge-type heaters. These are of sufficient capacity to bring the system from atmospheric pressure to 1,500 pounds per square inch atmospheric in approximately 4 hours. The heater control is designed to cycle about 10 percent of the heater capacity to maintain 1,500 pounds per square inch atmospheric during operation.

The pressurizer is sized to accommodate the contraction and expansion of the primary coolant due to changes in steam demand. It is equipped with a spray nozzle connected with the reactor for additional pressure control and possible degasification, and contains a water level control device with high and low limit indicators.

Mounted on the top of the vessel is a pressure relief valve set to discharge 1,800 pounds per square inch atmospheric. The effluent from this valve is piped to the waste disposal system. A surge line connects the bottom of the vessel to the oulet of the reactor.

All possible air entrapment volumes in the system will be vented and with the exception of the reactor, drain lines will be connected to any potential water trap.

Each boiler consists of two major components: an evaporator section and a separate steam drum.

The evaporator section consists of U-shaped stainless steel tubes, the ends of which are welded into heavy tube sheets, enclosed in a U-shaped carbon steel shell. This design eliminates the need for an expansion joint in the shell, since differential thermal expansion will be taken up in the return bend. The primary coolant flows through the tubes.

Steam is generated in water surrounding the tubes and flows up to the steam drum, which is sufficiently elevated to create natural circulation, through riser pipes. Both riser and downcomer pipes are large enough and numerous enough to permit natural circulation. To insure dry steam at the main steam outlet, Babcock & Wilcox cyclone separators, complete with plate-type scrubbers, are installed in the drum.

With feed water at 332° F. each of the 4 boilers will generate about 472,000 pounds of saturated steam per hour at a pressure of 420 pounds per square inch atmospheric pressure under full power conditions. The total output, then, will be 1,888,000 pounds of steam per hour, or 500,000 kilowatts of heat. As load is varied the reactor will be controlled to maintain constant steam pressure.

These units will generate steam at a rate commensurate with the heat supplied to them even at loads significantly less than 500 kilowatts. Thus, during emergency cooling periods, as well as during normal reactor operation, they will serve as a good heat sink, removing excess heat from the system at a rate which will adequately cool the reactor and the other components.

During shutdown heat will continue to be generated in the fuel elements of the reactor by radioactive decay of the irradiated material. Normal shutdown procedures are such that the elements are cooled by forced convection until they are able to be cooled by natural circulation.

In the event of power failure, emergency drives attached to one main cooling pump in each loop will supply adequate circulation during the danger period.

The two main coolant pumps in each of the four circuits operate in parallel. Normally they operate at constant speed for all reactor loads. As stated, however, one pump in each loop can be operated at low speed from an emergency power supply. The pumps are of the canned rotor type.

As you can see in figure 1, the 4 coolant loops are contained in 2 large containment spheres, 2 per sphere. The spheres are about 70 feet in diameter and are made of 1¼-inch steel plate. They will be capable of containing all the steam which might be created by a major rupture of the primary system.

Time does not permit discussion of the water makeup and purification equipment, the pressurizer, the fuel handling equipment, the instrumentation, et cetera, but I can assure you that these components are being designed with as much care and diligence as we can muster.

To set the record straight, however, I should mentioned that since figure 1 was drawn we have decided to change our method of removing and storing spent fuel elements.

Rather than transferring them by means of an inclined pipe through the side of the reactor containment tank to a cooling pit partially under the tank as shown, they will be lifted out of the containment tank into a water-filled canal just above the tank and horizontally through the canal to a cooling pit at the same level as the upper part of the tank. This will simplify the handling techniques and be less likely to damage the elements. Perhaps more important than the design work we have done on this project are the laboratory tests we propose to carry out to check our calculations and to determine the properties of the materials which we intend to use.

First, we plan to conduct a series of critical experiments—a critical experiment is one which involves a chain-reacting core which simulates the final core nuclearwise, but which is run at very low power and usually low temperature pressure. These will be performed in a special facility we have just completed for this purpose at our nuclear development center near Lynchburg, Va. A picture of this facility is shown in figure 3.

The high portion of this building is a large vault with 3-foot concrete walls in which "hot" experiments can be conducted. The rest of the building consists of supporting laboratories, counting rooms, machine shops, and offices.

The Consolidated Edison thorium reactor test series will involve a full-scale core, fully loaded with fuel. The objectives of these experiments will be to:

1. Check critical mass and neutron spectrum calculations.
2. Determine control rod worth and power distribution.
3. Measure thermal and resonance capture of neutrons in thorium, U–235 and U–233.
4. Measure the uniform temperature coefficient of reactivity, the doppler coefficient of reactivity, and the void coefficient as a function of position in the core.
5. Make danger coefficient measurements with actual reactor fuel elements.

These experiments will be initiated about September 15, 1956, and should be completed within 12 months.

We are also fabricating a test loop for insertion in the materials testing reactor at the National Reactor Testing Station in Idaho to determine the radiation stability of thorium. Twenty-eight pieces of thorium and of thorium-uranium alloy clad with zircaloy–2 will be placed in a high pressure water circulating loop which is designed to simulate actual reactor pressure temperature conditions and the assembly will be placed in the MTR for irradiation of the test pieces to 10,000 MWD/ton.

After irradiation the samples will be examined for dimensional stability, hardness of the clad, density of the "meat" and the "meat"-to-clad bond. These tests will not be completed until the middle of 1958.

And, finally, at the company's research and development center in Alliance, Ohio, we are—

1. Studying corrosion by water of both clad and unclad thorium.
2. Studying galvanic corrosion between stainless and carbon steels.
3. Investigating various pressure vessel closures.
4. Thermal cycling all structural materials in water.
5. Running corrosion tests in water between—
    1. Aluminum and zirconium,
    2. Aluminum and thorium,
    3. Stainless steel and zirconium.
6. Performing certain fuel element development and tests.
7. Studying boron steel welding and fabrication.
8. Developing improved fabrication methods for zirconium and thorium.
9. Determining fatigue properties of austenitic stainless steel at elevated temperatures.

Additional fuel element development work will, of course, be carried on the nuclear fabrication plant which we recently put into operation at our Lynchburg site—figure 4. The fuel elements for this project will be made in this plant.

If the members of the committee would like to visit Lynchburg site to see at first-hand what a small segment of the power industry is doing to implement the provisions of the Atomic Energy Act of 1954, the doors are open to you. We would be honored to show you these facilities at any time.

Thank you.

(The charts submitted by Mr. Landis follow:)

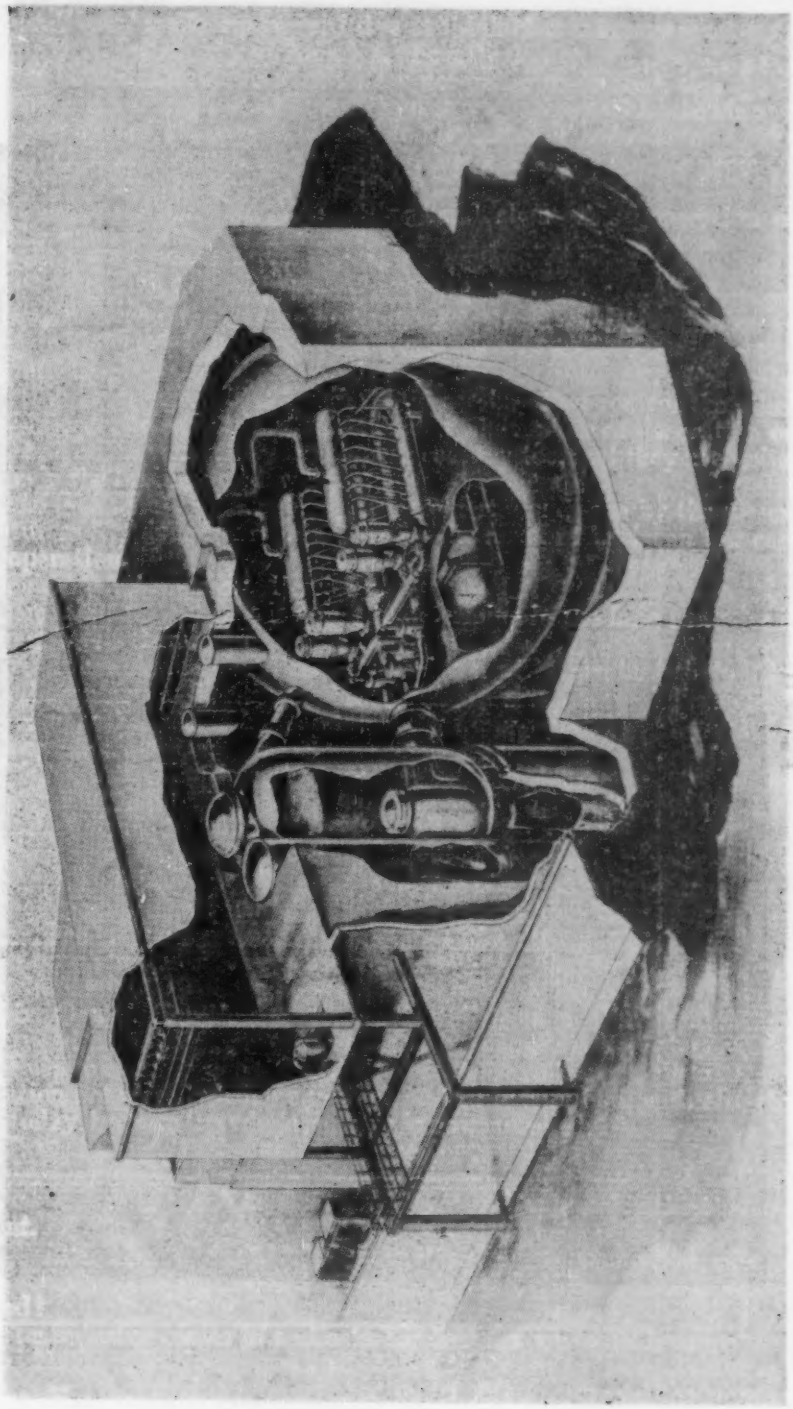
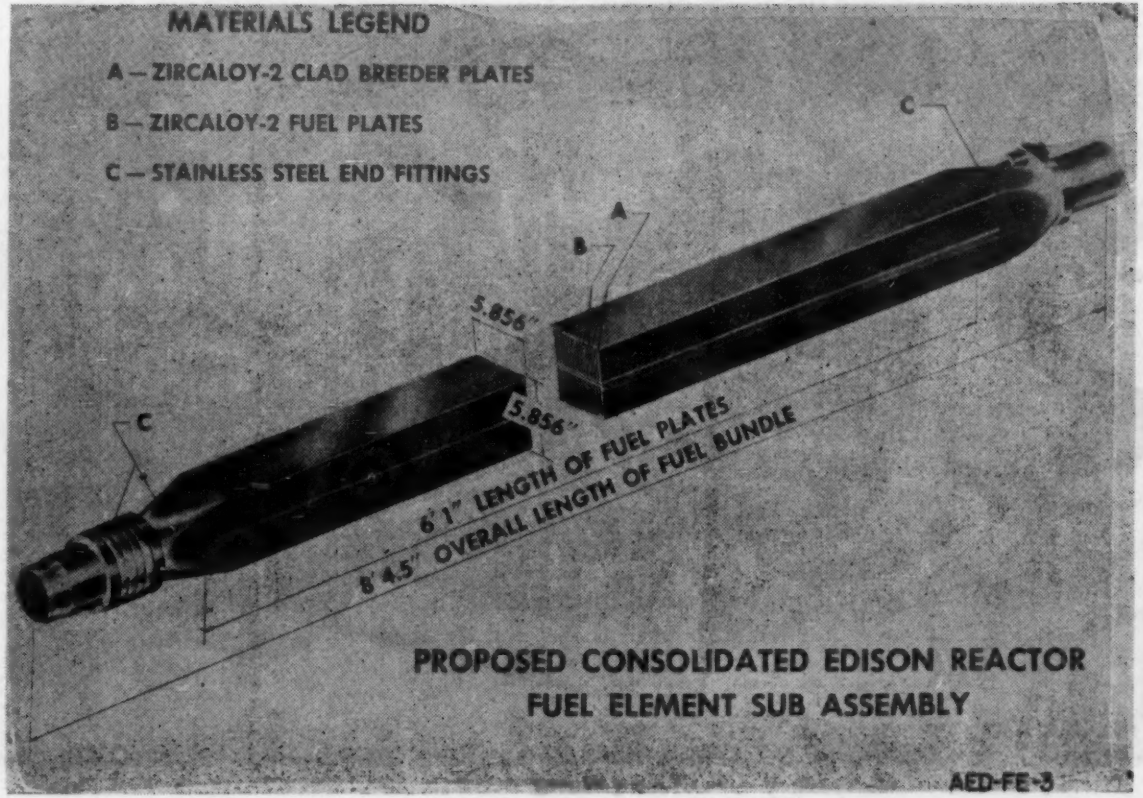


FIGURE 1

FIGURE II


MATERIALS LEGEND
A — ZIRCALOY-2 CLAD BREEDER PLATES
B — ZIRCALOY-2 FUEL PLATES
C — STAINLESS STEEL END FITTINGS
C
A
B
5.856"
5.856"
C
6' 1" LENGTH OF FUEL PLATES
8' 4.5" OVERALL LENGTH OF FUEL BUNDLE
PROPOSED CONSOLIDATED EDISON REACTOR
FUEL ELEMENT SUB ASSEMBLY
AED-FE-3

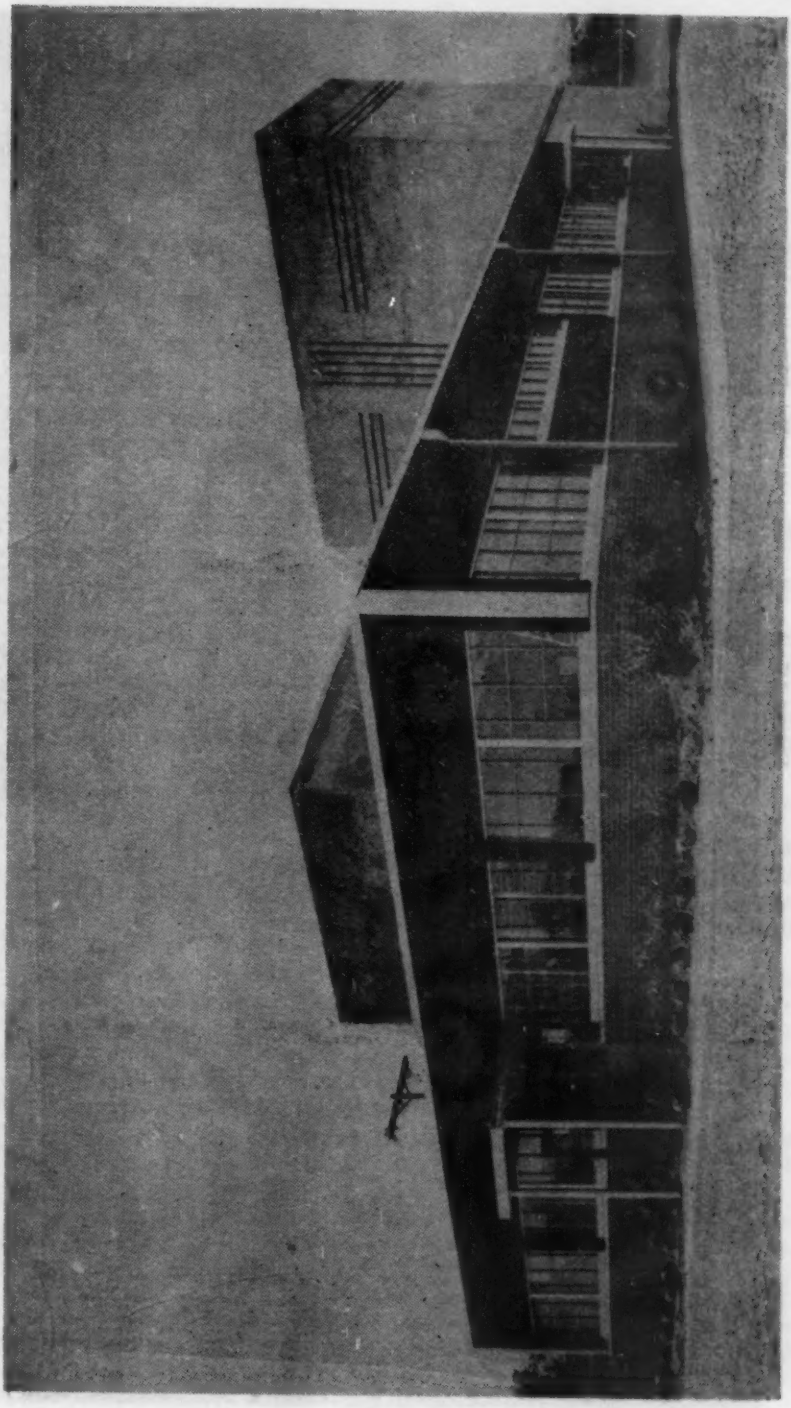


FIGURE III

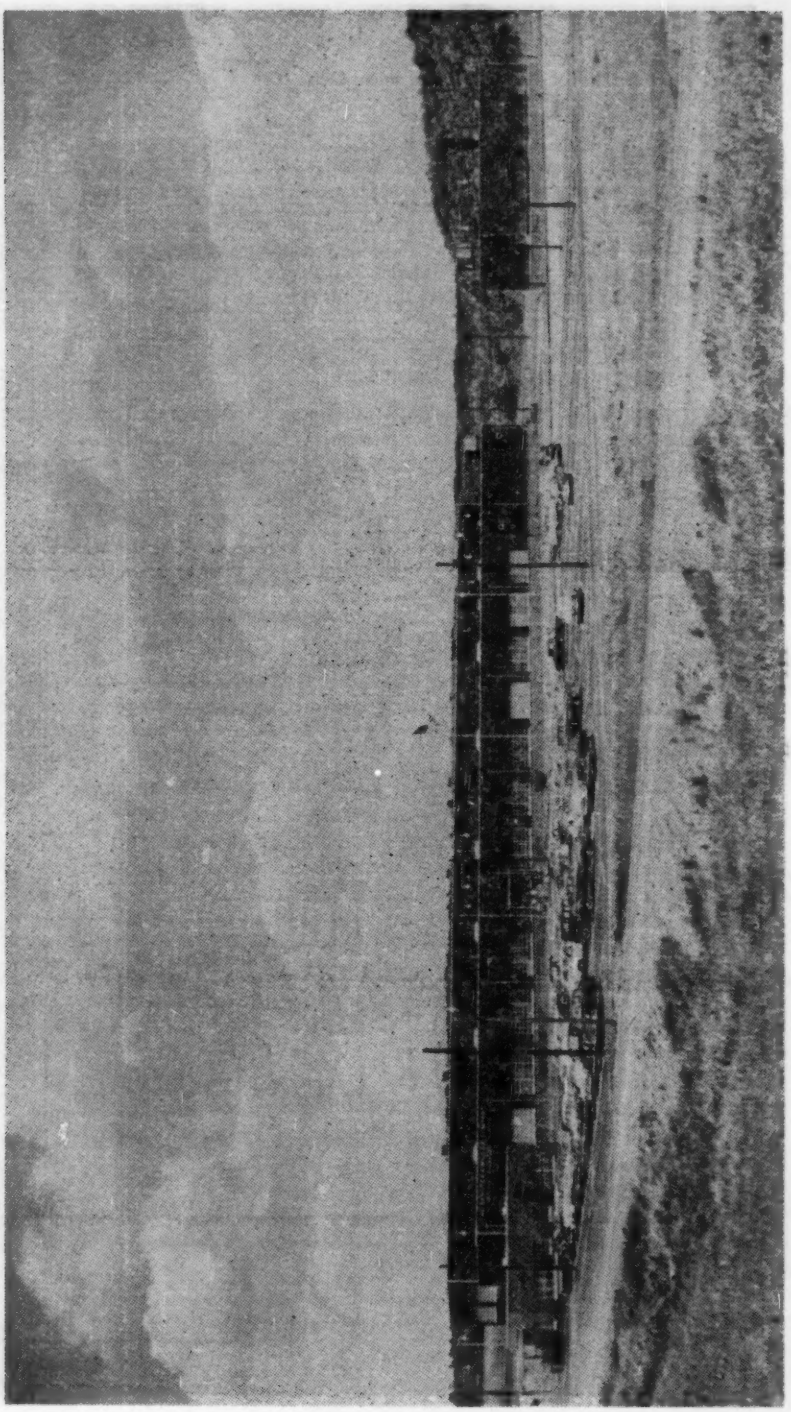


FIGURE IV

Senator PASTORE. Thank you very much for the invitation and I think we ought to consider very seriously the acceptance of it.

Dr. ZINN. I might say, Mr. Chairman, that I have visited the site that Mr. Landis mentions and certainly they are to be complimented on the fine job they have done in installing facilities.

Senator PASTORE. That is good to know, and I am glad that Dr. Zinn has considered that.

I want to thank you again, gentlemen, for your fine cooperation.

If there is anything further that you would like to add, I welcome you to do so. On the other hand, if you feel that you have concluded your testimony, I appreciate again your coming.

Mr. FAIRMAN. Thank you, sir. We appreciate the opportunity.

Senator PASTORE. Our next witness is Mr. Samuel B. Morris.

Mr. Morris, did you expect to read the entire statement?

STATEMENT OF SAMUEL B. MORRIS, CHAIRMAN, ATOMIC ENERGY COMMITTEE, AMERICAN PUBLIC POWER ASSOCIATION

Mr. MORRIS. That is what I expected to do.

Senator PASTORE. All right, if that is what you have expected. It is a rather long one.

Mr. MORRIS. Yes, it is rather long. I will hasten along, if I may.

Senator PASTORE. All right, sir.

Mr. MORRIS. My name is Samuel B. Morris. I am appearing here in behalf of the American Public Power Association as chairman of the atomic energy committee of that organization.

The American Public Power Association is a nonprofit association representing over 800 local publicly owned public utility systems in 40 States, Alaska, and Puerto Rico.

The headquarters of the organization is 1757 K Street NE., Washington 6, D. C.

My position is consultant to the Department of Water and Power of the city of Los Angeles, Calif. I have retired recently as general manager and chief engineer of the department. Before taking the Los Angeles position in 1944, I was dean of engineering at Stanford University.

I have served for a good many years as a member of scientific panels or committees advisory to the United States Department of Defense. I have also served as a member of the President's Water Resources Policy Commission, appointed in December 1950, and have been a member of the national water policy panel of the Engineers Joint Council, composed of the several national engineering societies.

As you know, I was a member of the Panel on the Impact of the Peaceful Uses of Atomic Energy—McKinney Panel—which was set up by this committee.

In his testimony before this committee on February 16, Mr. William S. Peterson, the president of the American Public Power Association, described the association's activities to date in the atomic energy program and the nature of our interest in atomic power development. In the interest of brevity I will not repeat that information here beyond assuring you that our member systems do have an active and direct interest in the expeditious development of atomic power and an equally great concern with seeing it developed in ways and under conditions which best serve the public interest.

As Mr. Peterson testified before this committee on February 16, and again on May 17, our association believes it necessary for the Federal Government to construct and operate some demonstration atomic powerplants if the civilian power-reactor program in this county is to move ahead rapidly and energetically.

I would like to emphasize at this point that we do not believe there is any issue of Federal versus private demonstration plants involved. We believe there are good reasons why the private- and consumer-owned utilities and the Federal Government all should go ahead with projects.

I think it is most unfortunate that the question of Federal demonstration plants is so frequently represented as an "either or" proposition, with the non-Federal projects falling by the wayside if the Federal Government builds so much as one demonstration atomic powerplant, other than the PWR. Our association does not take this position, any more than we would agree that the publication of some proposals to build non-Federal plants should exclude the Federal Government from the field.

It seems to us that the central questions before the committee are not those of public versus private power. The questions are:

First, whether we, as a nation, are seriously interested in the vigorous development of economic power; and

Second, whether our present programs and policies represent the best that we can do.

As to the first question, our association believes that high priority should be given to the development of economic power, for a number of reasons.

First, there are long-range economic considerations. The energy requirements of the United States are increasing very rapidly. A special study group for the McKinney panel forecast a requirement for electric generating capability by 1980 as high as 600 million kilowatts, more than 5 times our existing capacity.

Other emergency requirements are also increasing as our total population and use per capita both continue to grow.

Economic arguments have been used to show that the United States does not need to be in any hurry to develop atomic power because of our large reserves of fossil fuels and the advanced state of thermal power technology, which allow us to generate power from fossil fuels at very low costs compared to the rest of the world. This argument seems to us rather shortsighted. Having come as far as we have in the development of reactor technology, this short-term economic argument does not seem a valid basis for deferring the development of economic atomic power.

From a longer point of view, there is respectable evidence that we cannot afford such delay.

Although our reserves of fossil fuels are certainly large, so are our predicted requirements. There is every reason to take whatever steps we can now to conserve these resources and postpone the day when we shall exhaust our low-cost sources of supply.

Although it is believed in some quarters that our resources of coal are so large that we need not worry about their depletion, responsible analyses show that such complacency may be dangerous. A thorough analysis of United States and world energy resources and requirements made by the well-known consulting engineer, Mr. Palmer Putnam,

reached this general conclusion. Mr. Putnam's study was made under the auspices of the Atomic Energy Commission and published in 1953. I should like to quote some of Putnam's pertinent conclusions:

The United States and much of the free world—

said Mr. Putnam—

have been living high off accumulated capital energy in the cream of the coal, oil, and gas reserves. Rates of extraction of these nonrenewable fossil fuels have been unbelievable and efficiencies of use have trebled. Until quite recently the average efficiency of use has increased faster than the average cost of extracting raw fuel.

We cannot again treble the efficiency of use. Yet the costs of extraction continue to rise, while the average heat content in a ton of coal has begun to decline, at least in the United States. And the heavy conversion losses, when solid fuels are converted to the preferred fluid fuels and when both fuels are increasingly consumed in the generation of the more convenient but thermally less efficient electricity, are rising.

Low-cost reserves are growing scarce. By "low cost" is meant a cost, measured in 1950 dollars, that is no higher than two times 1950 costs. Reserves of such "low-cost" capital energy in the fossil fuels are small by comparison with the maximum plausible demands.

If, as is supposed, "low-cost" energy is essential to the liveliness of an economy, then new sources of low-cost energy must begin to carry some of the load by AD 1975, or sooner, and much of it by AD 2000, if we are not to run the risk of seeing economic systems throughout the non-Communist world falter in the face of steeply rising costs.

In respect to United States coal reserves, Mr. Putnam concluded that:

When this net effective reserve of economically recoverable cost * * * is matched against the maximum plausible cumulative demand, it is found to be enough to last until about AD 1995 * * *

What annual use of coal is implied in AD 1995? In that year * * * a twentyfold expansion of the 1950 coal-mining industry is implied.

Would this be technically feasible, or socially acceptable? To ask the question is to answer it.

Mr. Putnam concluded that a twentyfold increase in our coal-mining industry within 45 years is not something one could count on, and that:

The social and economic incentives to develop new sources of low-cost energy may become compelling in the United States before AD 1975.

Having compared the estimates of net economically recoverable reserves of fossil fuels with the maximum plausible demands in the United States, Putnam, recommending planning for the contingency, said that:

Peak production of oil-gas may be reached between 1955 and 1960.

Peak production of good coking bituminous coal may be reached before 1960.

Peak production of all coal in the eastern United States may be reached before 1975.

Peak production of all United States coal may be reached before 1990.

If we are to avoid the risk of seriously increased real unit costs of energy in the United States, then new low-cost sources should be ready to pick up much of the load by 1975, or sooner.

Putnam concluded by saying that:

The time for action has come—

and that

the economoic and social pressures directed at finding new sources of abundant low-cost energy are about to become compelling.

He urged:

*** * * that the Nation's talents, public and private, be released for the development of nuclear furnaces (reactors) capable of furnishing heat for the generation of electricity, for district central heating and for industrial process heating.**

*** * * that we continue to explore nuclear reactions other than the fission of uranium and thorium. There is some hope that we can domesticate the fusion reaction that makes the hydrogen bomb go. Economical fusion of the hydrogen contained in a cubic mile of sea water would be a source of capital energy equal to all conceivable needs for many hundreds of years * * ***

Furthermore, the introduction of another major source of energy should be encouraged in order to provide cost competition for the fossil fuels and thus tend to restrict the continual advance in cost of fuel energy. Although we have made steady progress in reducing the unit consumption of fossil fuels per kilowatt hour of energy produced, the power industry is faced with similarly steady increases in the unit costs of these fuels and further price increases can be expected in the future as demand continues to climb.

Within the past 8 months we in southern California, for example, have experienced sharp increases in the price of fuel oil, the principal fuel for thermal powerplants in the area.

Not only that, despite the general assurances of a plentiful national supply of oil, the Los Angeles Department of Water and Power has been having great difficulty in obtaining sufficient supplies of oil for our existing powerplants, even at sharply increased prices. What the price and supply situation will be in a few years, when our generation requirements will be substantially greater, I do not know, but we would be glad to have available an alternate source of economic energy such as atomic power. The department is preparing for the utilization of atomic power whenever it becomes economically practical.

The argument that we do not have to develop atomic power rapidly does not prove that for economic reasons we should not do so. In terms of present power costs and existing fossil fuel reserves, it is certainly true that if we have we can wait longer than many other countries to develop atomic power. However, a similar line of reasoning would have delayed indefinitely the development of the automobile, television, and other new technologies since, as far as I know, there were no compelling economic reasons for their rapid development.

As a matter of fact, a good many people thought that we were getting along quite well with the horse. Yet the rapid development of these technologies has had far-reaching and generally beneficial economic consequences which could not have been forecast.

Similar benefits can be expected from atomic power development. There is also the necessity of conserving our fossil fuels for higher economic use as lubricants, protective coatings, plastics, and many other increasing long-time uses for which atomic energy offers no substitute.

Following the analogies mentioned above, one could argue that in a similar way the Government should allow industry to decide how fast to develop atomic power. However, in the case of atomic power, the Government has the inescapable responsibility of deciding how rapidly we shall develop the technology. It cannot avoid or shift this responsibility by transferring the burden of the job to industry

because industry cannot go ahead in the absence of Government assistance.

It is evident from these and previous hearings of this committee that the Government is not escaping this responsibility.

All things considered, therefore, our association believes that there is nothing to be gained and substantial economic benefits to be lost by a slow development of atomic power, paced to short-range considerations of present power costs and fossil fuel reserves.

A further reason for pressing ahead with a specific program for developing atomic power is, of course, our responsibilities for international leadership. It seems to me imperative that the country which was the first to develop and use atomic energy for military purposes also be the leader in developing and putting to use the peacetime applications of this resource.

The United States position in atomic power development is due entirely to the Government development and construction programs started in earlier years. If the Government had not initiated and provided virtually all of the financing for the PWR at Shippingport, Pa., there would be no sizable power reactor under construction in the United States today.

Had it not been for the Government programs to develop and build the submarine reactors, Westinghouse could have sold no reactor to Belgium, nor could the Atomic Energy Commission state as it does that this country has been producing atomic power for some years.

If it had not been for the willingness of our people to make the investments, there would today today be no experimental breeder reactor, no homogeneous reactor experiment, no experimental boiling-water reactor, and the others.

Private industry today would not be making any proposals to build demonstration atomic powerplants if it were not for the public investments of the past because private industry would not have the necessary technological information, nor would it have the experienced technical manpower which is likewise essential.

Senator ANDERSON. Would it not be fair to say, however, that there would have been a development of some character in some other countries going on right along?

Mr. MORRIS. Yes, sir; that is true.

Senator ANDERSON. And that would have been more tragic to our country if we had not been in this business under the circumstances?

Mr. MORRIS. Yes, sir. I apologize to you, Senator, for reading my text so closely that I didn't see you arrive.

These familiar facts illustrate that we are at our present state of development because of public investments and Government actions. The necessary and logical next step in our development program is the construction and operation of some demonstration reactors, and if at this step the program falters we can hardly expect to retain our international leadership for long.

I do not think we should belittle the British and Russian programs. Reports indicate that both of these nations are serious about making progress in the technology as well as in the early construction of power-producing plants. The first large British plant, of 60,000 or more kilowatts of electrical capacity, is an experimental operation right now according to press dispatches last week.

Apparently, this type of plant is not too promising as an efficient power producer. However, perhaps we should not be too scornful of the first British plant, or that of the Russians, either, since our first plant, the PWR, is expected to produce 52 mill power—not an especially impressive figure.

In addition, the British have a fast breeder reactor of 60,000 kilowatts electrical capacity under construction and in this respect may be ahead of us on an advanced and promising type of reactor. They are reported also to be operating an experimental homogeneous reactor and working on the technology of sodium-cooled plants. Whether they are ahead or behind, they are working hard on a definite long-range program.

Dr. ZINN. That is not 60,000 electrical kilowatts. That is 60,000 kilowatts of heat. It is about twelve or fifteen thousand kilowatts electrical.

Mr. MORRIS. Thank you for the correction.

The statistics on the Russian program are familiar to you, I assume, and I will not go into detail on them. Their program for 2 to 2.5 million kilowatts of installed atomic power capacity by 1960 is very ambitious, and the comments of their representatives at Geneva on the 5,000-kilowatt plant they have been operating reflect their intention to strive for technical improvement as well as power production. They, too, appear to be in earnest, and judging from published reports of United States scientists, the Russians are displaying considerable competence in atomic-energy research.

Senator ANDERSON. Mr. Morris, I think you were not here when we had some discussion of this 5,000-kilowatt plant of the Russians, and tried to point out that there is evidence of very fine technical knowledge in it. I do not say it is the last word in scientific advances, but it is not anything hastily thrown together, because they have some things in that that we have found very difficult to achieve.

I am glad you mentioned it here.

Mr. MORRIS. They have been giving much publicity to that plant.

While the British program is spurred by immediate economic compulsions that we do not have, I have tried to illustrate that we also stand to gain economic benefits from the early development of atomic power. I do not think that we need to justify a vigorous program solely or even chiefly on the grounds that it would be desirable from the standpoint of our international relations.

The potential economic benefits of a very large new power resource coupled with our responsibilities for world leadership in developing it are adequate reasons for going forward energetically with the development of central station atomic power.

If we are to assign a high priority to the development of nuclear power, the second question is that of how to do this most effectively and in ways that best serve the public interest.

The American Public Power Association believes that the present program in the United States is all right as far as it goes, but that it will not be sufficiently effective unless the Federal Government exercises stronger leadership. There are deficiencies in our present program which in our opinion could be corrected by undertaking a Government program for the construction of some demonstration atomic power plants, along the lines proposed by the identical bills introduced by Senator Gore and Congressman Holifield.

We would urge that this Government program be a supplement to and not in lieu of the projects proposed by the private and consumer owned utilities.

The principal reasons for moving ahead promptly with some Government demonstration reactors may be summarized as follows:

1. The Federal Government is financially much more able to undertake promptly and push to completion some prototype plants than is private industry. The costs and risks of these first plants are very large. Many difficult technical problems remain, requiring large research expenditures. In our opinion the United States program is showing signs of lagging because industry is financially unable to assume the full risks and burdens associated with these undertakings.

The commiteee hearings on the insurance problem are the most recent tangible proof of this.

We urge that in recognition of this fact the Government proceed now to break the present bottlenecks by initiating construction of plants of promising design, rather than allow our progress to be held up while complicated arrangements are worked out for various forms of Government assistance to the utilities who wish to go ahead with projects of their own.

2. The construction and operation by the Government of some demonstration plants would be the logical capstone to the Government program, which now includes the construction and operation of small experimental power reactors, but stops short of constructing and experimenting with the necessary but more costly full-scale prototypes.

3. The prompt undertaking of 6 demonstration plants in addition to the plants proposed for construction during the next 6 years by the utility industry would help greatly in solving some of the cost problems. The costs of such items as pumps, valves, fuel elements, and other components are high partly because they are virtually custom-made items.

Such Government projects not only would expand the market for such components and by this alone encourage cost reductions, but it would firm up this market a great deal.

Equipment manufacturers would be encouraged to decide upon their own plans and programs more rapidly than they can now.

There are some areas, particularly the reprocessing of fuel elements, where the capital investments are so large and the market so nebulous that there is as yet no private industrial capability at all. Definite plans for some Government demonstration projects would enable industry to move into this area much more surely.

4. The addition of Government plants to the demonstration program should result in broader competitive situation in the equipment manufacturing industry and offset any trend toward monopolistic conditions.

There are a number of manufacturing companies interested in getting into the power reactor field who have not yet been able to get a project. If they are unable to get orders within the next few years, numbers of them may have to abandon the field.

The list of 10 bidders on the AEC liquid metal fuel reactor project is a recent illustration of the untapped industrial potential for power reactor manufacture.

In addition, there are numerous smaller companies competent in such highly specialized fields as instrumentation, controls, and so

forth, that could be brought into the power reactor field by a larger construction program.

In the past, these small firms have been a rich source of invention and provided an invaluable element of competition not always contributed by the very large companies.

We would recommend strongly that any Government program to construct demonstration plants be administered so as to bring in new contractors, both large and small.

Commissioner Libby and Mr. Kenneth Davis of AEC have both said that the AEC program badly needs new contractors.

Senator ANDERSON. You say the AEC program badly needs new contractors and you mention Mr. Libby and Mr. Davis who agree with that.

Then up above you mention the list of 10 bidders on the AEC liquid metal fuel reactor project, but that went to Babcock & Wilcox who already had a tremendous lot of work.

It did not bring in a new contractor. I quite agree that we maybe have to consider ways and means so that we can bring in some new contractors as well.

Mr. MORRIS. Yes; We feel that is a very important element.

An increased number of contractors would bring in new ideas, and increase competition. Active encouragement to small- and medium-size firms would help offset any tendency for domination of the field by a few large corporations and be a most effective step toward bringing down the costs of atomic power.

5. Government projects not only could move ahead more rapidly than private ones, without waiting for the completion and operation of the small experimental reactors, but also could afford to be more experimental in their construction and operation.

The Government could afford to try out component designs which might be too uncertain for industry to use without lengthy advance testing.

In the operation of the plants, the Government could afford more in the way of experimental operation and the testing of new types of fuel elements and other components than a utility which had to operate the plant at an optimum load factor and as nearly like a commercial plant as possible in order to minimize losses.

6. The private utilities may well build some demonstration plants. But this is not, by itself, the fastest way to get ahead. For optimum progress, these prototypes should be integral parts of a large and forward looking research and development program on metals, components, instrumentation, and so forth, so that the "second generation" of full scale plants will be markedly better than the first ones.

Who is going to pay for this essential research and development? Industry surely will finance some of it, but the job appears too large for industry alone.

I think you will find that the Government will have to pay for the lion's share of this work, just as it has to date, unless we are willing to accept a modest rate of improvement.

Assuming this is true, the Government's program should include some full-scale prototypes if it is to be a well-rounded program aimed at maximizing the public benefits of atomic power.

7. Similarly, in harmony with the Government's policy of multipurpose development resources, Government constructed and op-

erated plants could place greater emphasis and devote more research and experimentation to the byproduce uses of radiation. This should be of particular importance in areas where new industrial development is an important need. For these reasons, our association believes that the prompt construction and operation of some demonstration atomic powerplants by the Government would be sound policy, justified in terms of national economic benefits and necessary if we are to maintain our international position in the field.

Specific comments on the Gore and Holifield bills: In addition to my remarks on the general policy represented by the identical bills introduced by Senator Gore and Congressman Holifield, I should like to make a few specific comments about particular features of this legislation.

We recommend that the legislation include provisions for marketing and wheeling the energy produced by the Federal demonstration plants. In conformity with long-established Federal power marketing policies, section 44 of the Atomic Energy Act of 1954 requires the Atomic Energy Commission to give preference and priority to public bodies and cooperatives in marketing energy produced incident to the operation of research, development, and production facilities of the Commission.

However, the experience of our members in attempting to obtain power from AEC's West Milton, N. Y., facility has illustrated that a single private utility can nullify this provision. Because of the utility's refusal to transmit the power from the facility to the customers at anything resembling a reasonable charge, AEC says that it is powerless to comply with the clear intent of the law.

We, therefore, suggest that provisions be included in the Gore bill for marketing the power from these reactors in a manner that will permit the more effective implementation of the marketing policy contained in the Atomic Energy Act of 1954.

However, we do not believe that AEC should become involved in matters which are not directly related to its primary responsibilities. We therefore recommend that the Gore-Holifield bill be amended to provide that the energy produced incident to the operation of facilities of the Atomic Energy Commission, including demonstration atomic powerplants, and which is not used by AEC in its own installations, be marketed by the Department of the Interior or other appropriate Federal power-producing agency in the area of the AEC facility, under the applicable power marketing provisions of the acts under which these agencies operate.

The requirements in the bill that each plant be of different design and be located in a different geographical area seem desirable. We suggest that it might be equally desirable for several different size ranges to be represented within the group of plants to be built, in order to advance the technology of types of plants applicable to utility systems of various sizes.

Subsection (d) of the bill states that:

> The reactor construction program authorized by this act shall be in addition to the reactor development program being carried out by private or public groups under licenses authorized by section 103 of the Atomic Energy Act of 1954.

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I believe that this sentence needs to be amended to read "section 103 or section 104," inasmuch as all of the plants proposed to date by public or private groups will be licensed under section 104.

Senator ANDERSON. I would like to say that Senator Gore agrees with that.

Senator PASTORE. Do you think that section 103 ought to be in there at all, sir?

Mr. MORRIS. I see no harm in it. I would leave that to your legislative discretion. I should think both should be in.

Senator PASTORE. Section 103 has to do with the license once it becomes practicable.

Mr. MORRIS. Yes, sir.

Senator PASTORE. Would you envisage then that the Federal Government would then be permanently in the business for the manufacture of electric power to be distributed to public utility companies?

Mr. MORRIS. I would say not generally so.

Senator PASTORE. Would not section 103 mean that?

Mr. MORRIS. If the Federal Government, for instance, had a plant which was primarily serving some of its own installations that had some extra power and should at a stage become economic in that operation, I wouldn't expect them to shut that down because it became economic, but I would expect them to continue this fringe service.

Senator PASTORE. Not shut it down, but dispose of it like we have disposed of other plants where it became the policy of the Government not to engage in the activities of private industry.

That is the point I make. I am afraid we start out by saying we are not going to confuse this private versus public and then in fact we do confuse it by specifically so providing in the bill.

I think myself of that, that position ought to be made very, very clear, as to exactly what we intend to do with these six reactors. Do we expect to develop the research of this art, or are we actually going to build up reactors in order to start manufacturing power on the part of the Government?

I wonder if the Government should be in the field that far, any more than the Government should start to generate, let say, steam and heat through the use of coal in gigantic steam plants.

Mr. MORRIS. I believe if the Government reactor should prove to be economic, in the case which I cited, I assumed one primary purpose was serving AEC installations, and I see no objection to serving that alone.

Senator PASTORE. I see no objection to that, either.

Mr. MORRIS. If, on the other hand, a large reactor or a small reactor, for that matter, should later prove an economical installation, I should not like to see the Government hamstrung in respect to the best means of disposal of either the plant or its production.

Senator PASTORE. You have a good argument there, or an argument at least, that needs some clarification in order to convince me, but, on the other hand, I would not want anything to happen here that would deter the Government from building these six reactors, experimental reactors, in order to promote the art, and then have it tied up originally in an argument of public versus private that in my humble opinion will never bring about the passage of the bill, not at any time. So I do not think we ought to confuse it at this stage.

Maybe that is a problem that ought to be worked out later on, but I think we ought to make it abundantly clear that the problem we have here now is to develop the art in research and there will be 15 or 20 years possibly at the outside, before we get to the position where this is going to be economically competitive with the use of fossil fuels, and I do not think we ought to mix it up at this juncture in order to delay the passage of the bill.

Mr. MORRIS. I should certainly hope that the time would be shorter and I am sure we all do.

I should like to introduce into the record, immediately following my testimony, two resolutions unanimously adopted at the recent annual convention of the American Public Power Association.

The first endorses a policy of having the United States Government shoulder a greater part of the risks involved in the nonfederally sponsored demonstration projects, and also undertake itself the construction and operation of demonstration atomic powerplants. In his testimony before this committee on May 17, Mr. Peterson presented the association's views on the subject of a greater assumption of risks by the Government.

The second resolution recommends the power-marketing policy which I have discussed.

Thank you very much for this opportunity to present the views of the American Public Power Association.

Senator ANDERSON. Thank you very much, Mr. Morris.

We will make those two resolutions a part of the record.

(The resolutions referred to follow:)

RESOLUTION NO. 15—SPEEDING THE DEMONSTRATION POWER REACTOR PROGRAM

Whereas it is apparent to all that the demonstration full-scale power reactor program is lagging behind desirable schedules due among other reasons to:

1. The difficulty of forecasting and guaranteeing true costs,
2. The expectation or, even certainty, that the costs of electric generation in the first round of demonstration reactors of all capacities will greatly exceed the cost of power produced from conventional fuels, and
3. The failure so far to secure adequate third party risk insurance at reasonable cost; and

Whereas too great emphasis upon public utilities assuming high risks places an undue burden upon their customers, and the assumption of high risks by the individual manufacturers narrows competition, tending toward monopoly by the few largest manufacturers: Now, therefore, be it

Resolved, That the American Public Power Association hereby urges the Atomic Energy Commission and the Joint Committee on Atomic Energy of the Congress to speed the demonstration power reactor program and endorses a policy of having the United States Government (1) shoulder a greater part of the risks involved in the construction and operation of reactors in both the large and small power demonstration reactor programs, with full public disclosure of the Federal contribution and tax benefits provided, and (2) itself undertake in the public interest the construction and operation of atomic powerplants of each representative type in both the large and small demonstration reactor programs.

Adopted April 26, 1956, at Los Angeles, Calif., at the annual convention of the American Public Power Association.

RESOLUTION NO. 25—MARKETING OF ATOMIC POWER

Whereas the Atomic Energy Commission has undertaken certain reactor projects for research and development which may produce electric power in connection with its responsibility for nuclear reactor development; and

Whereas the Atomic Energy Act of 1954 contains a provision giving preference to public and cooperative agencies in the marketing of power produced from such facilities; and

Whereas there appears to be little possibility that the privately owned utilities will cooperate with the public agencies and cooperatives in the wheeling of this power to preference customers: Now, therefore, be it

Resolved, That the Department of the Interior or other appropriate Federal agency be empowered by Congress to provide for the marketing and wheeling of this power to the preference customers involved.

Adopted April 26, 1956, at Los Angeles, Calif., at the annual convention of the American Public Power Association.

Mr. MORRIS. There is a charge that this is a crash program. It might be called a moderate or crash program, but I have a feeling that if we do not proceed in this manner, with the tremendous increase in use of power in this country and the increasing cost of fossil fuels and increasing shortage of fossil fuels, we will run into a major crash program if we delay the economic development of atomic power; that at a time perhaps 10 years from now or 15 years or some other date, we would be in a greater crash program to try to satisfy our own needs for additional sources of energy.

Senator PASTORE. Another further argument. Mr. Morris, I don't want to prolong this any more than it has to be, but the argument is made that we don't need them so much domestically and we need them in foreign countries, and then why don't we make them in foreign countries.

At the same time, the argument is made why should the Government be in it at all, because we don't have enough technicians, engineers, physicists, mathematicians and all. How are we going to send them all over the globe if we haven't enough of them here?

It seems to me if you are going to do this and do it effectively, you have to do it in this country. If you perfected them and if you want to make some agreements with foreign countries, that is the time to do it then, but we certainly can't be sending our scientists all over creation in order to build these reactors in foreign countries and at the same time use the argument that the Government can't get into this under the Gore bill because we haven't enough men to go around.

Mr. MORRIS. I agree with you, and I believe the building of these in this country would be a self-generating, additional source of trained men who will work on these installations. Regarding foreign installations, I would feel that we should not make foreign installations for production of electricity until we are certain that the type which we are installing will operate. I would consider it quite a calamity if we should, in a development stage in a foreign country, build an atomic reactor which would not function satisfactorily.

Senator PASTORE. That is right.

Mr. MORRIS. Those things should be done at home.

Senator PASTORE. I agree with you.

Chairman ANDERSON. Thank you, Mr. Morris. Come back again.

Mr. Montgomery, is this your statement, or is this Mr. Reuther's statement which his illness made it impossible for him to present?

Mr. MONTGOMERY. It is Mr. Reuther's statement, Mr. Chairman, approved by him, and he asked me to present it. He asked me, Mr. Chairman and members of the committee, to express his very real regret that he was unable to come and present this testimony. The doctor has him under wraps.

This is a question on which he feels very intensively and he certainly would not have missed this opportunity, but it is impossible for him to be here.

I want to say we appreciate the courtesy of letting me present his statement for him.

STATEMENT OF DONALD MONTGOMERY, ON BEHALF OF WALTER P. REUTHER, PRESIDENT, UNITED AUTOMOBILE WORKERS, AFL–CIO

Mr. MONTGOMERY. I urge the committee to report favorably the bill by Senator Gore, S. 2725, authorizing and directing the Atomic Energy Commission to build six power reactors designed to demonstrate the practical value of atomic power for commercial and industrial purposes.

Senator Gore proposes that the Government build these demonstration reactors because he believes that we are falling behind in the race to develop atomic energy for peaceful uses. AEC Commissioner Thomas Murray expressed the same fear to your committee on February 23 and recommended a crash program of Government reactor construction.

Our atomic-power program is shockingly inadequate when compared with what the Soviet Union is reported to have underway and compared with what we know the United Kingdom is doing and planning to do.

In the United States, only 60,000 kilowatts of atomic power capacity is under construction. This is the Shippingport reactor being built by the Government. Under the industry participation program, another 700,000 kilowatts may, by the most optimistic estimate, be developed by 1960, but none of this is as yet definitely assured.

The Soviet Union has announced that by 1960 it will have built 2 to 2½ million kilowatts of installed atomic-power capacity. The United Kingdom will begin to deliver atomic power this year, and over the next 10 years will develop an atomic-power capacity of more than 2 million kilowatts.

Despite the small scale of our atomic-power plans and the large degree of uncertainty that they will be carried through to completion, the Chairman of the Atomic Energy Commission asserts before your committee that we are not behind any country in this field. He expressed the opinion that we are inclined to overrate the capability of the Russians.

While Admiral Strauss belittles the reports from Russia, we read in the newspapers that some other Government official told you in executive session that Russia definitely leads the United States in its plans and programs for harnessing the atom to the production of electric power.

No issue of greater importance to the future of the United States, or to its position of world leadership, has come before this Congress. Every Member of Congress and all the American people are entitled to all information that is in the possession of our Government as to where we stand in the international race to be the first to develop the peaceful uses of atomic energy. Secrecy is no substitute for facing the facts. A vital decision is facing Congress; it should have all the available facts on which to make that decision.

Believing this question to be of the highest importance to our position in the world, I yesterday sent the following telegram to President Eisenhower:

In his official capacity of Chairman of the Atomic Energy Commission, Admiral Strauss on last Wednesday urged the Joint Committee on Atomic Energy to reject a proposal for Government construction of six large-scale reactors designed to demonstrate the practical value of atomic power for commercial purposes at earliest possible date.

He made light of reports that the Soviet Union is surpassing us in this field. Newspaper reports, however, indicate that other Government officials gave the committee in executive session an appraisal of Soviet progress which puts that country ahead of the United States in atomic power development.

This is a question of the highest national importance, especially in our relations with other nations of the free world.

If there is any information in the possession of the Government bearing upon the progress of the Soviet Union or other countries in this vital field, Congress and the American people should have it.

If the Russians are forging ahead of us, Congress and the American people should be told. Then they will make the decisions necessary to insure that the United States regain and retain the lead in developing atomic energy for the peaceful purposes of all the peoples of the world.

In view of public statements by highest military authorities comparing our defense and warmaking potential unfavorably with that of the Soviet Union, it is impossible to believe that facts on peaceful applications of the atom must be concealed from us for reasons of national security.

I respectfully urge you, Mr. President, to authorize all qualified persons in the executive branch to testify in open session of the Joint Committee on Atomic Energy with respect to any information or evaluation of Russian atomic power development in their possession.

This is of highest urgency because of the proposal to step up our own atomic-power program which the Joint Committee is now considering and which should be acted upon in this session of Congress.

Mr. Chairman, we have examined with considerable care the arguments advanced by Chairman Strauss in opposing the proposals of Commissioner Murray and Senator Gore, and will give the committee our views with respect to those arguments. First, however, I cannot let pass Admiral Strauss' complacent comment that we tend to overrate the capabilities of the Soviet Union.

We all have seen this same wishful contempt for Russian capability carefully built up and rudely broken down with respect, first, to the A-bomb; second, the H-bomb; third, jet planes; and fourth, guided missiles.

How many times do we have to have it proved to us that contempt and complacency toward the Soviet Union are no substitute for foresight and achievement on the part of the United States? Admiral Strauss, himself, takes pride in having warned against some of these earlier blind spots in public policy.

On the peaceful uses of the atom, however, Strauss tells us we are doing fine and have nothing to worry about. I wonder if you happened to note the fact that the same morning editions which reported his testimony before your committee also carried a dispatch from Moscow amplifying the Soviet program of atomic power installations, another dispatch from Moscow reporting the praises of top American physicists for Russian research in high-energy physics and the excellence of scientific training in Russian schools, and the report from Washington saying the Central Intelligence Agency has told your committee that Russia is definitely ahead of the United States in its atomic-power program.

Admiral Strauss is entitled to his personal opinion that this Russian atomic program is a bluff, that the Russians don't mean it, or can't carry it out even if they do. But no one in a position of public responsibility is justified in asking the United States to gamble on the chance that the Russians do not mean business.

I want to assure you, on the basis of what I saw on my recent trip to India, that we dare not underrate the capacity of the Russians to deliver, especially when it serves their purpose of world domination to do so.

I was told, for example, how over a period of 5 years India sought investment help from private enterprise in America and Britain to develop its steel industry. It could not get that help. It has now obtained a 12-year loan from Russia at 2½ percent, with Indian technicians to be trained in Russia and with Russian technicians serving under the Indian Iron and Steel Ministry.

In Bombay, I saw the permanent machine tool exhibit maintained by the Soviet Union there. I know machine tools, and I can assure you these are the most modern type of tools, all kinds of tools, anything you want, and in addition to machine tools, they are offering welding equipment, agricultural machinery, bulldozers, earth-moving equipment, dump trucks, fire trucks, even linotype machines with the type in any language—all available at favorable prices with long-term repayment arrangements.

Now, they appear to be forging ahead to prove up the practical ways of generating power from the atom. The collective Communist dictatorship in the Kremlin understands the tremendous psychological and propaganda weapon that will flow from leadership in harnessing the atom to man's peaceful needs. If the Soviet Union succeeds in being the first to offer atomic power reactors to power-hungry underdeveloped nations, this can be a powerful and decisive factor in their program of economic penetration and political subversion.

We cannot run the risk that the Soviet Union will outmatch us in this field, and there is no need to gamble on it. If the available resources of this country, both public and private, are enlisted to the fullest possible extent to put the atom to work for peaceful purposes, we can be sure of regaining the supremacy which once was ours in putting the atom to work for war.

This kind of all-out effort is, as I read it, exactly what this committee was recommending in 1954 when it reported the bill for revising the Atomic Energy Act:

> We do not believe that the efforts of free enterprise, using its own resources and moneys, are by themselves adequate to achieve the speediest possible attack on the goal of peacetime power. Neither do we believe that maximum progress toward this objective will be afforded by an effort relying exclusively on governmental research and development, using the public's moneys.
>
> We believe, rather, that teamwork between Government and industry—teamwork of the type encouraged by these amendments—is the key to optimum progress, efficiency, and economy in this area of atomic endeavor. In other words, our legislative proposals aim at encouraging flourishing research and development programs under both Government and private auspices.

This language is wholly in harmony with the Government participation prescribed by the Gore bill which, in fact, merely implements section 32 of the 1954 act by providing the specific authorization required by section 261.

Since Chairman Strauss quotes these same words from your 1954 report and comes to a different conclusion as to what they mean, let us examine the reasons which he and the Commission majority have advanced before your committee for opposing the recommendations of Commissioner Murray and Senator Gore.

First, he argues that the Government need not build large-scale reactors because our goal should be for economic nuclear power, not mere kilowatts of power. He says:

> The mere number of kilowatts of capacity to be in existence by 1960 is not, in our view, very meaningful. * * * If there were some logical reason for doing so, the United States could unquestionably build millions of kilowatts of nuclear generating capacity by 1960—but it would not be economically competitive power. We do not consider the fact that some other countries have announced plans to build a specific kilowatt capacity a persuasive reason for us to start a crash program to outmatch them.

The fact is, of course, that the only way to make atomic power economically competitive is by building large-scale demonstration reactors. Twice in his own statement Admiral Strauss made the point that—

> only a full-scale reactor can provide the cost information and the engineering improvements that are necessary to achieve significantly lower costs.

It is perfectly clear, and Strauss knows it, that Senator Gore and Commissioner Murray are urging that these Government reactors be built not merely to add to our kilowatt total, but to speed up the technological advance that will bring the cost of atomic power down to competitive levels.

Commissioner Murray said:

> There is the further question of the economics of nuclear power. Earlier this month, the Commission reported on its reactor program in hearings before your committee. This report was pervaded by the concept that the economics of atomic power are of greater importance than getting the job done at an early date. This is simply an extension of that viewpoint which would have found in economics the basis for a course of inaction on the Shippingport reactor.
>
> For my part. I believe that the United States will not mount the necessary program and complete it within the requisite time schedule as long as the economics of the program is the decisive consideration. The decisive consideration must be the demands of public policy, that is, our need to maintain a commanding lead in the field of atomic power, and to this end to place power reactors in operation, in adequate numbers, at home and abroad, at an early date.
>
> This is our fundamental problem—to carry through this public policy to a successful issue. The fundamental problem at the moment is not a matter of costs; the program I recommend would be sound even though the projected costs were more than double that of power produced in the United States. The reason is that public policy is the controlling factor here.
>
> In thus giving considerations of public policy the primacy over considerations of cost, I do not mean to minimize the importance of costs. Obviously, our objective must be to develop reactors which promise power at a lower cost. However, I repeat my belief that we shall reach this objective most surely and quickly by building and operating reactors. By doing this, we shall also develop the broad base in personnel and in facilities needed to support an expanding nuclear power program.

These excerpts are from the hearings February 23, 1956, page 294.

Strauss says that the emphasis of Government participation should be upon the earlier stages of design, feasibility, and experiment, while the private industrial effort should be on construction of full-scale prototype reactors. This is how the Commission now proposes to make atomic power economically competitive. Yet Commissioner Vance, testifying for the Commission on February 29, admitted that

we can't expect an all-out investment effort by private capital until it has become competitive:

> As a simple matter of economics, until the use of atomic energy as a source of electric power is reasonably competitive in cost with the use of conventional sources, we cannot expect extensive use of private capital to exploit it for commercial purposes.
>
> Competitive costs for the use of atomic power are not in immediate prospect, although it is our hope and expectation that further technological progresses will accomplish this goal (hearings, p. 323).

So where does that leave us? The Commission waits for private investment to make atomic power competitive; private investment waits until it has become competitive. A more sure-fire formula for disastrous delay on a program of the greatest national urgency could hardly be devised.

Commissioner Murray hit this nail on the head when he was before you on February 23. He said:

> Mr. Cole, if you put this on the basis of economics, and that is your only motive in going ahead, you don't go ahead in this business (hearings, p. 306).

To be sure, the Commission does recognize that its program may not work and that the Government may have to move in and do what the Gore bill proposes. But it is in no hurry about that. It reveals no sense of urgency. Asked by Senator Anderson, "How long would it be reasonable to wait?" Commissioner Vance, speaking for the Commission, said:

> I think until there is some indication that one or more of these types hold the greatest promise for commercial exploitation, we are not in a position to determine how much a full-scale installation will contribute to the art, whether it be financed by public funds or private funds. Personally, I believe that is one of the reasons why private capital is waiting for that particular point to develop. Now you ask me when. Possibly 2 years, or maybe sooner (hearings, Feb. 29, 1956, p. 329).

Eleven years have passed since the war. Almost 2 years have been used up since Congress opened the atomic field to peacetime uses. Do we have 2 more years to wait and see? Of course we do not. The rest of the world will not stand by while we belabor the stupid argument that private funds are somehow better than public funds for achieving a vital national purpose. As this committee so well said in the passage I have quoted, we need both public and private funds, public and private skills and know-how, all used to the best advantage to get on with the job.

Neither Government nor industry can do this job alone. It was the blending of the special contributions of each that provided the genius which gave America the atomic know-how to produce the first bomb. At this stage of our national effort, nothing could be more tragic than to split our forces by engaging in a sterile and senseless fighting of ideological windmills.

Our free enterprise system is not being challenged in America. If it were, less than 1 percent of the American people would support such a challenge, for the American people understand clearly that our free economy motivated by individual initiative and enterprise has given them a higher standard of living than any other people enjoy. We must approach this problem free from preconceived prejudices or fixed theoretical or ideological positions. We need to make judgments on a sane and sensible basis as to how best we can, as a free nation and a free people, get the job done.

Another argument advanced by the Commission against the Gore and Murray proposal is that the Commission would have to carry out the additional responsibilities given it by working with the same companies it is working with now. Commissioner Libby said:

> The critical matter in the development of atomic power, I believe, is not money nor uranium, but it is technical manpower necessary to solve the problems. These men are in large part employees of private industry. So even if we proceed with a Government-financed program, we still have to get these companies to build the plants in order that we get the men they have on their payroll to work on them (hearings, Feb. 29, 1956, p. 343).

Admiral Strauss made the same point in reply to a question by Senator Pastore at the hearings on last Wednesday.

While there is no question about the scarcity of skilled manpower and the pirating of trained personnel from AEC into private employment, it is not true that the Commission would do business with the same companies under the Gore bill as under the present program.

The active participants in the present program are, and must be, companies that are in the business of selling electric power—the private electric utilities, public power groups, and electric cooperatives. Under the Gore bill the Commission would contract with the designers and manufacturers of equipment and the builders of plants.

Far from diverting scarce talent from more important tasks, as Admiral Strauss contends, the AEC reactor construction program could enlist most of the talent that has been hired by these manufacturers and contractors. Better coordinated use of the available talent could be accomplished than is now the case.

That many of these scarce talents may not be finding a place in the present program is suggested by the fact that 12 companies submitted bids to build the experimental liquid metal fuel reactor for Brookhaven National Laboratory. Presumably all of them were equipped with the necessary talent. Yet only one got the job. That one happened to be Babcock & Wilcox, which already is heavily involved in other reactor projects.

Chairman ANDERSON. I realize this is Mr. Reuther's statement, and perhaps he should be the one to comment on it, but in his absence, I am glad you picked that point up. I tried to make it a few moments ago when Mr. Morris was testifying, that 12 firms wanted to do the job, but it naturally went to a firm that already had a great deal of work, already had a great deal of responsibilities, and therefore, presumably was farther along with this particular task than other firms that hadn't had a chance to get cleared personnel, for example, and hadn't had a chance to get the experience they have had.

It does seem to me that there is a real field for some of these other firms. Then I think, in addition, there are large organizations, as I pointed out a day or 2 ago, the du Pont organization built the Savannah River plant and operated it and has a greater reserve of manpower than it uses, and can always find a way of taking out a person here and there if it is given a new Government job.

Certainly its record proves that. Yet it is not being tapped for one of these experimental reactor jobs. I am glad to have the emphasis that Mr. Reuther has put on this in this statement.

Mr. MONTGOMERY. In the separate opinion Mr. Reuther filed with this committee as a member of the panel of the impact of peaceful use of atomic energy, he developed this point to some extent, point-

ing out that the drawing off of these experts in private employment, which was a natural thing to happen, tends to lessen their total value to the total program, because they are split up and just hired on one project at a time. We expressed the hope there that if the Government got into the building of reactors they would be able to tap these experts on a contract basis for all the different parts of its own program where they could be most useful and that this would tend to relieve the scarcity of these skilled people by making more of them available to get on with the job.

Senator PASTORE. Inasmuch as you have been interrupted, Mr. Montgomery, in your first sentence on page 8, you say:

> Admiral Strauss made the same point in reply to a question by Senator Pastore at the hearings on last Wednesday.

I hope that doesn't leave the impression that I entertain the same point of view, even though I asked the question, because I am not convinced that an effort that amounts to 200 or 300 million dollars in this country, and that is all it amounts to, on the part of private industry actually is exhausting all of our technical knowledge and all of our technicians in this particular field.

I think we are going pretty far afield. We built the biggest atomic program the world has ever known in the field of manufacturing weapons of war. We have built, I hope, the best storage or stockpile of atomic weapons the world knows, and now we are saying that an effort of $200 or $300 million, which is no more than it cost us to build the *Forrestal*, the aircraft carrier, will exhaust all of our technical knowledge, and all our technicians and physicists, and what have you, in the development of this field.

I am not thoroughly convinced that we have exhausted it or can exhaust it with that small effort, but I do say this, though: That a point ought to be made here that our Government effort ought to be tied down to the research and development of this under section 104 lest we get ourselves in this argument of private versus public power, because I think at this stage it would be rather dangerous and would only serve to deter whatever participation there should be on the part of the Government.

Mr. MONTGOMERY. I am sure, Senator Pastore, this reference here wasn't intended to commit you to Admiral Strauss' point of view.

Senator PASTORE. I did ask that question because that point was rasied, but I am not convinced that that is the situation.

Chairman ANDERSON. I think it is good to have the reference to the statement cleared up.

Go ahead, Mr. Montgomery.

Mr. MONTGOMERY. An AEC reactor construction program would not only make more effective use of scarce skills, it would enlarge the opportunity for that part of private enterprise which shows a keen interest in atomic power development. Manufacturers have far more at stake here than the electric utility companies which, under the present program, have been given both the initiative and the veto power on atomic development.

For manufacturers it opens a vast new field of profitable opportunities. To utility companies it carries a threat of displacing conventional power facilities as the cost of nuclear power is reduced.

Commissioner Murray noted that his proposal would enlist the services of that part of private enterprise which has most to contribute to progress in this new field. He said:

> Many of our outstanding companies, whose assets run into the billions, have been intimately associated with the Commission as major contractors over the last 10 years. These companies know everything that we know about nuclear reactor technology; in fact, most of our knowledge in this field was originally developed by them for us in our facilities (hearings, Feb. 23, 1956, p. 294).

Senator Gore's proposal will not eliminate private enterprise from this important undertaking. It will greatly extend the opportunity for private enterprise to participate and make its contributions. It will promote the best possible employment and coordination of scarce skills, including those poeple who, trained by the Commission, have been attracted into private employment.

Admiral Strauss said in this connection that private enterprise would not have the usual incentive to cut costs if Government builds the reactors. This, he said, would delay the achievement of economically competitive atomic power.

Even though AEC may be as indifferent to cutting costs as Admiral Strauss would have you believe, the actual building of the reactors will be done by private manufacturers and contractors. They have strong incentives to discover how atomic power may be produced cheaply, since this will open up large new areas of business opportunity.

Their incentives will be no less when they are building reactors for the Government than when building them for electric utility companies, and they will have more opportunity more quickly to put their incentives to work. This is the important thing—for them and for all of us.

A third argument advanced by Admiral Strauss against the Gore bill is that we have little need for nuclear power—

> in view of the low cost of conventional power in this country—

and—

> in the face of the very intense competition from very efficient low-cost conventional energy.

While we agree that the most urgent need for developing atomic power with all possible speed is the international challenge that faces us, it is entirely wrong to assume that our domestic power needs are assured for a comfortable period ahead.

> We need atomic power, not to supplant the conventional sources of electricity, but to supplement them, and thus keep up with our steadily mounting demand for electrical energy which has been doubling about every 10 years. We cannot afford to delay until the crisis is upon us.

These last two sentences are in quotation marks because they are the words of Admiral Strauss in a speech delivered at Case Institute on November 29, 1955.

Reliable estimates of future power needs in this country show that in the next 25 years we shall have to add 4 times as many kilowatts of installed power capacity as we have developed over the past 50 years. This means we shall have to develop new power facilities eight times as rapidly as we have done in the past—a staggering challenge. Nuclear power must make an important contribution to this great increase in our power supply.

As for our "very efficient low-cost conventional energy," some parts of our country have not been sharing this blessing. An outstanding example of efficient high-cost power is to be found in New England, as I am sure Senator Pastore knows. Michigan, Wisconsin, and Minnesota run it a close second in this respect.

An AEC survey of some two dozen large new powerplants built since the war found that half of them were producing power at no more than 6 mills per kilowatt-hour, and the highest cost among them was 9 mills. By contrast, many New England municipalities and electric cooperatives pay 12, 13, 15, and even 16 mills for wholesale delivered power.

Of course, that is delivered power as compared with bus bar power for the rates above. Nevertheless, the spread between them is very significant.

A group of industry experts who prepared atomic power cost estimates for the McKinney panel arrived at figures which indicate real possibilities of relief for high-cost areas like New England within not too many years. These estimates, analyzed on the basis of other reports furnished to the panel, show a distinct possibility of very low-cost power from atomic energy, as set forth in an appendix to the separate opinion which I filed with this committee. This has now been printed in the hearings of your committee at page 566 where it appears as a document filed by Andrew J. Biemiller, testifying for AFL–CIO on March 6, 1956.

Another argument advanced by Admiral Strauss against an all-out Government reactor program appears to imply that the job is just too big for the Atomic Energy Commission. He told you, for example, that it would take too much of the time of their highly qualified personnel to buy the concrete, bricks, mortar, machinery, and hardware required for these reactors.

Commissioner Libby told you it would take AEC 4 or 5 years to build these reactors, and Admiral Strauss expressed the opinion that we could not keep up with the Soviet Union even if the Government does build reactors. Finally, he said, AEC doesn't know how to distribute and market the power which these reactors will generate, and Commissioner Libby said that they would find the preference clause a considerable burden.

Those statements attributed to Mr. Libby are in the letter that he addressed to you on May 18, Mr. Chairman.

As to the last point, it seems to us that Congress might, in due course, designate a competent authority to market power from the AEC reactors. The Dixon-Yates experience does not recommend AEC for that assignment. But the issue before this committee and Congress right now is to get the reactors built, to move ahead vigorously in developing atomic energy as a practical source of electric power. We suspect that AEC will manage somehow to find a competent contractor who will know how to buy the requisite concrete, bricks, and mortar.

This is our review of the arguments advanced by the Commission majority against the proposals of Commissioner Murray and Senator Gore. We submit that the arguments are not impressive. They seem to reflect not so much a conviction as a fixed frame of mind. Doctrinaire ideology with respect to the role of private enterprise appears

to mean more to the Commissioners than any sense of urgency about regaining and keeping our leadership in atomic-power development.

How little sense of urgency the Commissioners feel about this task is made all too clear by their testimony before your committee on February 29. There they gave you as proof of wholly satisfactory progress under the present program the claim that private enterprise has committed all of $250 million to the building of demonstration reactors—hearings, page 334.

Under questioning it was conceded, of course, that very little of this sum was actually committed. But more significant is the fact that the Commission majority looks upon $250 million as evidence of adequate progress in this great new field of enterprise. It is only a token contribution. Private electric utilities invested $4.3 billion in new conventional facilities in 1955. I might add in the first quarter of 1956 they were investing in new facilities at a rate of $5.2 billion a year.

Just one company, Commonwealth Edison, invests on the average $150 million a year in new facilities. This is from the testimony of Willis Gale, hearings February 16, 1956, page 245.

Chairman ANDERSON. So it is a matter of 5 percent, maybe, or something of that nature.

Mr. MONTGOMERY. This $250 million?

Chairman ANDERSON. Yes.

Mr. MONTGOMERY. Chicken feed.

Senator PASTORE. And that is for 5 years.

Mr. MONTGOMERY. Yes; and we are not sure of that. This is paper investment so far, and if I had time to, I would like to go on to say it isn't their own money, either. A lot of it is ratepayers' money and some of it is taxpayers' money, and we are all going to contribute, but that is a side issue, maybe.

A commitment of only $250 million toward this great task is convincing proof of the frightening fact that we here in the United States are not facing up to the challenge and the opportunity of the atomic age. We simply have not sized up the job to be done. Admiral Strauss dramatically revealed how low he sets his own sights when, with apparent elation, he announced to your committee on February 29 that his colleagues had just advised him that private enterprise participants will spend 20 to 25 million dollars this year on the reactor program—hearings, page 344.

This point of view is reminiscent of the "business as usual" attitude that kept cropping up during the war years. "Business as usual" does not meet the challenge of war. Nor will it meet the challenge of peace which atomic energy has put up to us.

Fortunately, the decision which means so much to the future of our country and its place in the world is one that your committee and the Congress must make.

I devoutly hope that it will be made on the side of devoting adequate resources, both public and private, to this task—a decision which once and for all will replace the creeping complacency of the Atomic Energy Commission with a sense of national urgency, so that the United States may lead the way into an atomic age where the atom will be dedicated to the service of man, not to his destruction.

Chairman ANDERSON. That is a very good statement. I hope you express our thanks to Mr. Reuther for it. I just had occasion to note

the other day that the Iceland Parliament asked us politely to move out of Iceland after a short time. We had spent $200 million building those air projects up there at the request of Iceland. I assume from this that it might be your opinion that that $200 million spent in atomic development internationally might have produced greater results.

Thank you very much.

Mr. MONTGOMERY. Thank you, Mr. Chairman.

Chairman ANDERSON. We will resume at 2 o'clock.

(Whereupon, at 12:20 p. m., the committee recessed, to reconvene at 2 p. m., the same day.)

AFTERNOON SESSION

Chairman ANDERSON. The Joint Committee will be in order.

This afternoon we will open the hearings with the statement of Mr. John Jay Hopkins, president of the General Dynamics Corp. Mr. Hopkins, we are glad that you are back here to testify for us.

STATEMENT OF JOHN JAY HOPKINS, CHAIRMAN OF THE BOARD AND PRESIDENT OF THE GENERAL DYNAMICS CORP.

Mr. HOPKINS. Mr. Chairman and members of the committee, it is a great pleasure to be accorded the opportunity of presenting to you certain views of mine in respect to the civilian atomic energy program.

I should like to say at once that I do not presume to represent here any specific industry or any special group. My own company with its galaxy of supermodern defense products is, of course, also vitally concerned with the future of nuclear energy. But I have neither desire nor reason to plead my personal business interests before this distinguished Joint Committee.

While I am now serving as the first and organizing chairman of the newly established nuclear energy committee of the National Association of Manufacturers, my views as expressed here today are in no sense a reflection of the official nuclear-energy policy of that association.

As a matter of fact the official policy has not yet been formulated. When—within a year, this Committee, now but 3 months old, has been lifted out of the cradle and set on its way with, I hope, a vigorous leadership, a constructive program of education and aid in the nuclear field to American industry, particularly to its small-business segments, of which in America is very representative, as you all know, and with a comprehensive policy of participation in international atomic trade, together with a philosophy embracing international benefit to all—then I shall consider that a worthwhile contribution will have been made in the public interest, and I shall gladly relinquish the chairmanship to other hands.

Therefore, I am here simply as an independent industrialist who has followed with interest atomic developments since the days of the Fermi demonstration and the Smythe report, and has hence acquired some general knowledge of the economic and social consequences of nuclear energy.

A private citizen, if you will, who believes that his observation may, perhaps, be of some aid to this Committee in solving the complex problems that confront the Nation. As such, of course, I seek to develop

no tight or rigorous theory; nor do I claim to have sifted all of the facts or even a small fraction of those data which sometimes pass as facts.

My effort is to point out relationships which may not have been obvious, or to suggest relationships which may not previously have seemed probable, in order to open up new avenues of thought and action.

In attempting to take in the widest possible area one sacrifices, of course, the intensity, and perhaps the clarity, of the narrow view. Yet it seems axiomatic that a basic of decision making is peripheral vision, a capacity for the panoramic look. But even that will not suffice; for the executive field of vision should not be circumscribed by the historical present.

It must be characterized also by a deep perception of the past, and the skill to forecast in terms of 20, or 50, or 100-year futures—irrespective of the forecaster's personal life span. That is why, I am sure, others who are charged with the direction of large enterprises dealing with forms of energy have not been at all astonished that certain definite proposals of mine relating to atomic energy, presented over the past 3 years, should have been framed in terms of 25 years, or 100 years, or even longer spans of time.

As you gentlemen know, many of our large corporations have staff economists and marketing specialists now forecasting the structure and function of the American industrial society of 1975, less than 20 years from now, and of 2025. We must, I believe, in respect to atomic energy, think and act, and be at ease, in such time schemes.

If we postulate that atomic energy is a new and revolutionary development, that no commercial operating and maintenance experience exists, that the technology is in a constantly fluid state, and that to many business executives the competitive cost picture seems at best most uncertain, the venture of private industry thus far is not inconsiderable.

It seems appropriate to point out that American private industry does have certain responsibilities and limitations which tend to inhibit rapid advances into new spheres where no experience record exists. Among these are, of course, the responsibility of the managers to the share owners, to the employees, and to the community.

There is first the personal obligation not to fail, there is second the practical obligation to pay for work produced, there is third the moral need to provide a reasonable return to those who have risked their funds to bring the enterprise into being and to keep it in being.

I am sure that all of you are quite familiar with these facts. I do not present them as any evidence of special pleading in behalf of private industry. I do feel that considering the circumstances and the limitations under which it must operate, private industry has done a good job.

I feel equally certain, however, that given time and opportunity private industry will do far more than a "good" job.

In my opinion, private industry would respond positively to more definitive direction from without and to more dynamic leadership from within. In view of the advances being made by the British and the Russians, I wonder if we do not suffer from an obsessive concern with negatively biased surveys, and from an unduly rigid insistence that atomic investment in facilities must be governed wholly by pre-

vious experience, regardless of whether that experience is even pertinent.

Nowhere, in our nonmilitary atomic business activities, can there be described that sense of urgency and dedication that marks the European entry into the industrial nuclear field. It has been said dozens of times in extenuation of our apparent apathy and in explanation of their obvious enterprise that European conventional fuel resources are far less. Yet if one considers the future demands of the world economy—and the patent fact that atomic energy is not alone the fuel of the future, but, in its medical, agricultural, biological, economic, political, and social aspects, is the super-eminent arbiter of all national destinies—negativistic or "play-safe" cost surveys, or endlessly contentious debate over the merits of fractionally differentiated reactor technologies become, in relation to the global and millenial magnitudes involved, little more than trivia. Not roadblocks, I should say—just grit in the gears of our progress!

I do not think that any one person, or one group, or indeed, any segment of our society can assume the role of leader, or solicit sole responsibility for the success or failure of our industrial atomic effort. The burden of responsibility for action, or lack of action, may rest in part but certainly not entirely on the shoulders of private industry; it may rest in part but not entirely on members of Government. Therefore, the burden must be borne not by a part of the American society but by the whole American society.

Chairman ANDERSON. If I may, I would like to interrupt you right there to say that I would be very happy to put my stamp of approval on that last sentence. I am not trying to put private industry out of the atomic energy business or push Government into the business but I have been very hopeful that these hearings would bring home to the American people that this reactor problem, whether it is a kilowatt race or whether it is not, is a very, very important problem to this Nation of ours, and it must be shouldered not just by private industry and not just by the Government but by the whole American society, and you have phrased it very well, and I appreciate your saying it.

Mr. HOPKINS. I have had great stimulation from reading 2 or 3 of your addresses on that point. I am very glad you express yourself so definitely on it.

The public interest requires immediate action because the future security and well-being of our Nation, and of the free world, rests squarely on the ability of our democratic society to achieve leadership in all new forms of energy—especially in atomic energy—and thereby to demonstrate, for all the world to see, that a democratic and free society is truly the most able to maintain such a leadership.

In limitless cheap energy put constructively to the freeing of all peoples from poverty, disease, and famine is the key to world peace! If rapid progress in nuclear energy is wholly and totally in the public interest, it must be wholly and totally in the private interest.

If it will govern the destinies of nations, it will also govern the destinies of domestic, social, and political and economic institutions. In an economic sense, nuclear energy will constitute property of incalculable value and dimension. Thus its control, ownership and use may well determine the future direction of American economic and political philosophy.

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This committee then, it seems to me, has an awesome responsibility to the people of our Nation. What is decided here with respect to the civilian atomic-energy program will chart, I predict, a historic policy in which every citizen must have a vital interest.

In respect to atomic energy there need be, then, no question of public interest versis private interest. There is, I feel, but one question, the question of how best to advance the economic welfare of the Nation in a manner consistent with our traditional social, political, and economic values; how best to maintain our scientific and technical leadership, yet still preserve individual initiative and freedom of opportunity.

It is a problem that has been faced often in the past. Invariably, the answers have been the same, and invariably they have been correct—a very real partnership between public interest and private interest for the benefits of all.

Over 3 years ago, on May 20, 1953, in Montreal, before a joint international meeting of the National Association of Credit Men of the United States and Canada, I made the point that in respect to atomic energy:

> Government monopoly has performed a necessary and exemplary job under the urgent pressure of defense needs. In a large measure it has succeeded so well because it has wisely enlisted the services of private industry to carry out its objectives. But the program must necessarily remain inhibited so long as objectives and goals are planned by the Government, controlled by Governmental budgets, and geared to essential Government needs.
>
> I feel very strongly—

I said then, early in 1953—

> as apparently does the Atomic Energy Commission—

as of that time—

> that the time has come when private enterprise—subject, of course, to security, safety, and raw material limitations—may be permitted to bring to bear on the development and production of atomic energy the same engineering, management, marketing, and financial genius which has developed for the common welfare the world's other power resources.
>
> Free competition in free markets will bring much closer the day when the blessings of this vast new source of power will be made widely available for peaceful purposes.

A year later, in 1954, this committee recommended, and Congress and the President approved, legislation which accorded to private industry substantial participation in the various applications of controled nuclear energy. In our atomic energy programs, therefore, partnership between American industry and its Government in recent years has existed and still exists.

Yet, I must confess that, in my opinion, it has been, and still is, an unequal partnership, with the Government the senior partner and industry very much the junior. This state of affairs, I am confident, will not long continue for it is foreign to the nature of our economic development; it runs counter to our heritage and has been, in my opinion, largely responsible for the apparently slow pace of this Nation's industrial atomic-energy program.

In a matter as crucial as this, I respectfully direct the attention of the committee to the consistent pattern of our industrial past—a pattern of partnership which has built, at least up to now, the greatest industrial Nation of all time.

The only departures from this tradition, except those committed by the Constitution to the exclusive care of the Federal Government, such as the Post Office, were those occasioned by acute crisis—either war or depression—and were always undertaken as temporary expedients.

It will be pertinent, I believe, to our atomic problems of today and tomorrow to comment, though briefly, on certain similar problems of yesterday—problems now small in hindsight, yet which no doubt loomed large to our predecessors. I have in mind the historic development of four industries, basic to any economy. They are: Agriculture, mineral extraction, metals fabrication, and transportation.

I think it permissible to say that the railroads have been the arteries of the growing tissue of the American economy. From its inception only 120 years ago, to the truly intricate networks of today that carry the lifeblood of the Nation, railroading has been a partnership—a symbiotic relationship—between the Government and private enterprise.

Municipal, State, and Federal Governments early recognized the private development of American railroads as a matter of public interest. With outright loans, bond issues, and land grants, often of imperial size and worth, all of the American people, by means of private management and individual stock ownership, underwrote railroad expansion until sufficient capital had been accumulated for rail transport to shift for itself.

We all recognize the corruption, mismanagement, and waste were unfortunate concomitants of this early development. None of us today would condone many of the practices that prevailed then. Yet the fact remains that the railroads reached out across the land, and in their tracks the country settled in with astonishing rapidity. In the space of but 40 years, railroads largely developed the American continent.

Private industry alone, however, could never have undertaken this task. Government alone could never have provided the motivations and incentives of adventure, industrial pioneering and expectation of reward that laid the rails and drove iron and golden spikes.

A similar development has been followed by the privately owned and operated shipping industry which, indeed, continues, even now, to require and to receive the support of Federal partnership—because such partnership is in the public interest. It is a fact that economic and geographic conditions are such that American shipping, either privately or publicly owned, operated and financed cannot possibly compete with foreign interests.

Yet the larger fact, the overriding reality that cancels out minor economies, is the fact that the United States must possess a mercantile marine to insure a strong position in world commerce and to fulfill the needs of national military emergencies.

Air transport has a like history of private initiative and public financial encouragement and support. Under every administration and every Congress since 1926 it has been a national policy that it is in the public interest to establish and maintain, through the subsidy of private carriers, comprehensive mail and travel routes. The public interest overrides the fact that financial or engineering surveys might well show many of them to be, at the moment, not vitally "necessary" or "economic", per se.

The privately owned and operated steel industry, the backbone of the American industrial economy, would very likely have languished for years had it not been for another device of Federal financial partnership—the protective tariff.

I should like to emphasize the astonishing relevance of the history of the steel industry to certain aspects of today's atomic power industry. It is especially worth noting here and now, at this juncture in world atomic power development, that Great Britain was the first western nation to recognize the supreme importance of steel to an industrial economy—and to act on that recognition.

Through a combination of Government encouragement, trade policy, liberal capital investment, and invention, the British rapidly built up, in the 1850's, the world's greatest steel industry.

Indeed, by 1865, British technology, production capacity, and labor and management skills were so far advanced that no other nation could possibly compete. British control of the world market in steel became absolute. For a decade, Great Britain, like the Roman Empire, levied tribute on all the world, including the United States.

American businessmen and Government leaders, however, realized that utter dependence on a foreign nation for a vital component of industrial progress was neither in the public nor the private interest. Public-spirited industrialists, such as Abram S. Hewitt, imported British techniques, and others, like Andrew Carnegie, prevailed upon the Government to provide a protective tariff which would permit the growth of a domestic steel industry despite foreign competition.

Thus, the American people, through a partnership of the Federal Government and private industry, insured the development of an American steel industry. Quite naturally, domestic steel was not, at first, competitive with British steel, either in cost or in quality. It was indeed most uneconomic. But with the public assisting, facilities were built and expanded; employees were trained; the technology was advanced; and huge domestic sources of raw material were opened up.

Even with the support of the Federal partner, however, pioneering steel industrialists took enormous risks—but risks that paid off enormously in the private and in the public interest. For instance, the elder Charlemagne Tower was literally down to his last dollar, and over 70 years of age, when his gamble on the Mesabi Range proved out. Other coal, iron, and steel entrepreneurs were equally as daring.

This national partnership—unplanned in any formal fashion because it was simply common sense—and with its sights focused intuitively decades into the future—achieved an industrial miracle.

Within a scant 25 years, the American steel industry, starting from a tiny, noncompetitive, definitely uneconomic nucleus, surpassed Great Britain in quantity of production, equaled her in quality of product, and—by virtue of enormous domestic coal and iron ore resources—not only undersold the British businessmen in the American market, but challenged their supremacy in the international market.

Without this shrewdly intuitive long-range planning, without this common sense partnership of public and private interest, without this precognition of economic and political things to come, America would today be a 10th rate power, or the vassel of some other state—and the whole world so much poorer.

As transportation and steel have been deemed historically in both the public and private interest, so also are the so-called extractive industries: Coal, oil and other minerals necessary for the Nation's security and economic welfare. Such resources are owned privately but because of the extraordinary hazards of exploration and development, and because their development and conservation are in the public interest they have always been aided by the public partner.

Liberal depletion allowances for tax purposes, or Government-pegged prices for strategic minerals, are the two principal manifestations of this Federal partnership in action. Favorable public policy, combined with private pioneering and risk capital, have brought in tremendous new deposits of vital domestic minerals and have encouraged greatly the development of efficient, scientific techniques for more reliable exploration, better methods of extraction, and sounder conservation practices.

I will not burden the committee with any lengthy discussion of public support for the privately owned and managed agricultural industry. All that I need say is that support for various crops, usually by means of bounties, antedates our existence as an independent Nation. Students of history know that British mercantilists actually prohibited the growth of their own domestic tobacco industry to insure, for tobacco grown in the American colonies, a desired monopoly position in the British Empire. Generations before the word "parity" became the subject of economic and political debate, indigo, sugarcane, rice and sugar beets, to name only a few of the more important, were supported in the public interest.

The fact is that virtually every American industry, from textiles to machine tools, from raw wool to sewing machines has been nurtured and protected in one form or another, at some time or another, through the power and protective action of the Federal partner. And always, the ultimate objective, it seems to me, has remained the same—the social and economic welfare of the people and the social and economic independence of the Nation in a perilous world.

Subsidies, bounties, tariffs, franchises, tax writeoffs, direct grants and loans have been among the devices employed. At times they were initiated by the Government, at other times by industry, and frequently at the behest of both. Partnership of public and private interests has been the pattern of at least the origins of national economic development since Hamilton's first report on manufactures.

Historically, it has always been the Government's function, where broad public interest is involved, initially to encourage, and to lend aid to, those economic developments from which, later, the Government has derived its tax revenues.

I have perhaps dwelt at too great length upon the historic precedents for public partnership—but not proprietorship—in pioneer industries. Yet I feel that the point must be made that the Government and the managers of private industry have a joint and vital interest in the future of industrial atomic energy and a joint and vital, and inescapable, responsibility to American citizens, shareowners and employees.

There are, it seems to me, five compelling reasons why our industrial atomic energy programs should be advancing faster, in order to serve better both the public and private interest.

1. The needs of an expanding economy: An expanding economy and an increasing population are sources of great satisfaction to all

of us because their interaction results in greater markets for more products, more skills, and more services.

Too few of us, however, have pondered the meaning of these indefinite expansions in relation to diminishing natural resources, or in terms of our present responsibility to provide not only a livelihood, but emotionally satisfying and productive career opportunities as well for the vast future population to come. Still fewer have faced the question in its staggering world dimensions—although one does not need to be a demographer to realize that the populations of many areas of the world are expanding much more rapidly than that of the United States.

The population of the United States stands now at approximately 167,440,000 souls. This is an increase of about 16 million, or 11 percent since 1950. The best statistical projections available estimate a population in 1975, less than 20 years from now, of about 60 million more people than today—a total exceeding 225 million in less than 20 years.

Industry, therefore, must provide in the next 20 years for a labor force of more than 100 million people. Such a task will exert exacting and unremitting pressure upon capital for the expansion of existing industries and the creation of new industries. Moreover, if the American standard of living continues to rise at the rate of the last 5 or 10 years, we will, of course, be consuming foodstuffs and mineral resources at several times the present rate of consumption.

Obviously, economic pressure will demand that some form of energy absorb much of this widening gap between consumer demand and the capacity of conventional resources to satisfy that demand. It is my belief that the principal industries which will grow up in and around applications of atomic energy should make major contributions to the creation of job opportunities for this added labor force.

Private industry has now the nucleus for expansion in these fields. Present facilities, experience, and skills could, I suppose, in time provide sufficient capital. But now there is no time: In this closely knit world of ours, neither private industry nor the Government can afford to wait for domestic economy necessity to force our hands, for competitor nations—some potentially hostile—will take the international lead and keep it.

2. Conservation: Closely associated with the needs of an expanding economy is the need for conservation of irreplaceable minerals. Coal and petroleum, for example, have many valuable properties other than those of providing energy. Many of these qualities are unique and there is little prospect of discovering equally good substitutes.

For most lubrication requirements oil is the optimum agent. Oil will certainly remain the primary fuel for many years in the powering of light and motive transportation. In the new, immensely valuable petrochemical industry, oil has such indispensable properties as to make its use as low-grade fuel an economic waste of the first magnitude.

Even coal, which is in much greater supply, should be the subject of conservation study and planning because its supply is finite and because it is basic to such valuable industries as aniline dye and synthetic fibers. Each year gained in shifting a portion of our electric power and heavy motive power to nuclear energy means many more

millions of barrels of irreplaceable petroleum, many more millions of tons of coal, that can be saved for special uses to enrich the living standards of future generations.

3. Nuclear energy is a revolutionary force—not merely in respect to power, but for agriculture, for medicine, for biology, and for chemistry. If we accept this assumption, and I believe we must in the light of available scientific and technical data, then the rate of atomic energy development and utilization is of the most far-reaching consequence to all humanity.

Factoring in the obviously looming foreign competition in the atomic energy field, and the rapidly expanding market for reactors, an atomic industrial development program becomes closely linked to our future national prosperity and security. For the rate of atomic energy development in the United States—and I do not refer solely to the power aspects of the atom—and the amount of experience gained from its actual applications govern whether we, as a Nation, will possess a vigorous, or a static nuclear technology, a strong or weak nuclear component industry, a substantial share of the expanding world market, or a minimal share.

4. International competition in science and technology make a powerful argument for accelerating our present efforts in controlled atomic energy. Since 1945, it has been increasingly apparent that a nation's overall strength may no longer be measured exclusively by such material and mechanistic indices as wealth of natural resources, favored geographic position, industrial plant, or by any combination of physical aspects.

Of paramount significance now, and of much greater significance for the future, are those human resources that sustain a nation's scientific and technical posture. Since the advent of nuclear energy, all industrial nations have recognized, though in varying degree, the vital importance of scientifically trained human resources. But what is not so clearly understood, at least in the United States, it seems to me, is the extent to which the nuclear revolution has jeopardized our traditional technical and production leadership.

First, from a national security standpoint, the United States has always in the past been able to rely on a combination of exclusive production-line genius and immense national resources to get up, in time, the striking power needed to destroy any one enemy, or coalition of enemies. Atomic and hydrogen weapons have now nullified the factors of a once-exclusive and decisive formula: Mass production capability $\times$ resources $\times$ time equal victory.

Secondly, the advent of nuclear energy has wrought a technological revolution of great magnitude, making obsolete many traditional engineering practices. And nuclear energy has brought to the fore the new concept of the sudden and unpredicted breakthrough which can cancel out immediately projects on which colossal amounts of money, time, and effort have been expended.

A breakthrough can overturn minor technical disciplines or upset a $10 billion program. A breakthrough can advance dramatically a "small" nation's domestic and foreign position. Conversely, it could seriously weaken or at a critical juncture jeopardize the national security of a "big" nation unfortunate enough to have spent its time and energy in technological blind alleys.

There is no presumption—since scientific genius is independent of political boundaries—that all or even some, significant breakthroughs will be achieved exclusively by Americans. I think we must frankly and publicly admit the possibility that, at some time in the future, we may be suddenly at the mercy of a potentially hostile nation which has—by the quantum-jump of a technological breakthrough—advanced years ahead of us. Nor need this breakthrough be in the purely military area: The economic quantum-jump is no less vital—and to it we are even more vulnerable.

I, personally, cannot reconcile what my senses of perception and intuition warn me of with any leasurely policies of wait-and-see, or nonpragmatic experimentation, or theoretical extra polations. Prototypes will be no more decisive in economic wars than in military conflicts. To put it bluntly, in my opinion, we must drive on now with a major nuclear energy policy and program, or be content with second, or even third place. May I suggest that any idea that we are competing individually with other nations is a deadly fallacy?

Our competition is the possible and probable combination of some nation of brilliant technical and design skill and the Soviet army or Chinese army of engineers and mass production technicians. That, gentlemen, could mean that we could become an atomic and economic have-not nation—on its way to oblivion.

These possibilities, verging toward probabilities, it seems to me, compel both industry and the Government to move swiftly to the implementation of the civilian atomic energy program. Time saved in this respect is added insurance that our security and our continued well-being will be protected, our technology immeasurably enriched.

In developing specifications for potential customers both here and abroad we should secure immense and practical benefits relating to construction and operating experience, particularly maintenance, safety information and costs. The imminence of hard competition for international markets by immensely skilled and knowledgeable nations like Great Britain, or very far-advanced nations of the most tremendous mass production potentials such as Russia, should lend a "fire alarm" urgency to our program.

Neither industry nor the Government can talk authoritative reactor costs, or much advance our industrial atomic energy program with economic surveys of paper projects alone.

At some time industry and the Government must sit down and resolve the cluster of interrelated problems which are now approached from different directions and from many different viewpoints.

Actual experience must be gained and gained quickly, or the United States may not only lose its present competitive advantage in the potentially rich, power-starved markets of underdeveloped areas, but be forced out of them completely with disastrous economic, political and moral consequences. Our current precarious nuclear leadership has been achieved through the investment by the American people of billions of dollars.

We must not squander this advantage by indecision or by inaction or by assumptions that we are permanently ahead.

5. Nuclear power as an instrument of foreign policy: I have considered generally the competitive nature of nuclear energy in world markets and have stated that this requires action from both the Government and industry. I should like now to comment briefly on the

political advantages to be gained in the so-called cold war by making atomic power available presently to uncommitted, underdeveloped nations as a prime mover in their efforts to industrialize.

It has long been my opinion, frequently expressed on public occasions, that small power reactors would, in most instances, be ideal to assist those nations—now possessing three-fifths of the world's population—in exploiting their inaccessible but rich natural resources, and to ease the economic burden of importing costly fossil fuels.

I advanced this suggestion in 1954 at the annual meeting of the National Association of Manufacturers, urging then, as now, the development of an industrial atomic energy program through the partnership of American Government and American industry.

Perhaps even more significant than the economic aspects of nonmilitary atomic energy is the fact that the peaceful atom has become a symbol of hope to those peoples who not only starve by the millions but, in growing despair and anger, see the gap widening instead of narrowing between the industrialized West and the agrarian East.

Atomic energy would be a tangible expression of aid in which all would eventually share irrespective of social strata. Moreover, the possession of a power and research reactor system would be a mighty aid not only to national integration, but in helping to direct the explosive force of nationalistic fervor into channels leading to international integration. Continued exclusive possession of atomic power, it seems to me, constantly emphasizes, to the underdeveloped nations, Western strength and achievement and by contrast magnifies Asian, or African weakness and poverty.

In our exclusive possession it acts as a powerful and, indeed, fateful mechanism for further advancing the advanced nations, further increasing instead of diminishing the already wide economic and cultural gap between "have" and "have-not" nations, and so bringing them beyond fatalism to hatred—and hence to violence.

In the absence of any coordinated atomic aid program and in the presence of the potency of the hydrogen and atomic weapons, it has been a simple matter for anti-Western propagandists to identify us with atomic destruction. As a result, in my opinion, our foreign policy has suffered—our obvious technical and economic superiority has produced fear and envy.

Chairman ANDERSON. Could I go back to the previous paragraph, where you said, "Continued exclusive possession of atomic power, it seems to me, constantly emphasizes, to the underdeveloped nations, Western strength and achievement." Do we have exclusive possession of atomic power?

Mr. HOPKINS. No, of course there is some in Britain and some in Russia. But it is the attitude of exclusiveness, and I am pleading for a more generous attitude in the bilaterals than we have now actually. I have exaggerated of course that point. I think the broad sense here is "exclusive possession" by the West.

Chairman ANDERSON. I would think the fact that Britain has put its first power unit on the line and is running it into its grid, and that Russia had a pretty good station operating in 1954 with high-grade advanced engineering, probably better than we have, would indicate that we do not have exclusive possession.

Mr. HOPKINS. We cannot sit on it certainly. We did take a very exclusive attitude on it up to a very few years ago. We thought then we were the leaders.

Chairman ANDERSON. You were at Geneva with all of us, and you found out there that it was not quite as exclusive as we thought it was.

Mr. HOPKINS. I think that they may have learned more from us than we learned from them but there was a lot to learn from everybody then.

Senator PASTORE. It was quite evident even at the Geneva Conference from all of the scientists from the rest of the world, exclusive of Great Britain and Russia, that we were considered the top Nation. We were the leaders and we were looked upon as such.

Mr. HOPKINS. That is a psychological exclusiveness; and we have been running around acting as though we were just the best people in the world and we knew all about everything. I was very much impressed with the address of President Sukarno recently when he spoke brilliantly, in English, about the hopes that the people had. He mentioned that his nation had been passed by on one previous occasion, referring to Vasco da Gama, and he hoped that this ship would wait for them.

Of course, an international atomic assistance program is no magic formula that will solve the complex problems of the underdeveloped nations. It will not take the place of ethical or moral policy, or obviate the need for cultural and spiritual development, or supplant compassion or commonsense. But economically, and politically, atomic power is a vast and integrating force, greater than any we have yet had, that can help to build industrial societies which these nations desire above all.

As I have said before, atomic energy is a matter of both public and private concern. Its ramifications are so all-encompassing, so all-pervasive that there is not one facet of world society that will escape its influence. Power of this scope is far too broad to be the province of any special interest, public or private.

Rapid progress is, indeed, necessary, but not at the expense of our initiative and our tradition as a free people. There must be, it seems to me, an integrated effort in which the people, working through their elected and appointed representatives and through their industrial organizations, will advance atomic energy for the benefit of the individual human entity as well as the entire body politic.

My remarks have stressed heretofore national self-interest and immediate action. However, we would be, in my opinion, tragically shortsighted and ethically wrong, if we should choose to regard this immense power with its limitless capacity for human benefit as merely an adjunct to national advantage or national dominance. It is my conviction that we are again being given by providence an opportunity, perhaps the last, to solve many of the world's perplexing problems. Morally, as well as pragmatically, we are, in view of our historic ideals, committed irrevocably to that course which will bring the boon of atomic energy—in all its multiforms—to the underdeveloped nations.

Chairman ANDERSON. Do you subsequently suggest how you think that that might be possible?

Mr. HOPKINS. Yes, I do. We have a specific program which we have kept very short, but I think it is a good starting point. I am

using this forum here to pour out my heart on things that I have been feeling for 3 years and talking about.

Chairman ANDERSON. That is very good.

Mr. HOPKINS. It has been logically worked out and, I hope, all hangs together. But I do have a very definite, and what I think is a constructive, suggestion for getting it started.

After speaking widely both in this country and in Canada during 1953 and early in 1954 on the coming atomic revolution, on massive atomic creation versus massive atomic destruction, and on atoms for peace—I proposed in December of 1954—as a first step toward achieving this cultural and economic goal, a 100-year program for the development of international atomic energy under the partnership of American Government and industry.

I suggested then that American Government and American industry assist underdeveloped nations directly to industrialize through atomic research reactors and small atomic power reactors, financed by American dollars in part already allocated by our Government on a repayment basis.

To raise living and cultural standards in Asia, southeast Asia, Egypt, Africa, Israel, and Latin America, I envisaged the implantation of atomic "seed" reactors in four categories over a period of 25 years. In Tokyo, a year ago, I proposed as a possible second step the development of a Free Asia Atomic Energy Community with the atomic "have" nations contributing to the development of atomic "have-not" nations.

In an effort to assist in easing the political rigidity which already seems to characterize American attempts to develop atomic power potentials for the "have-not" nations of the world—and the consequent inability of these nations to accept the boon of atomic power for fear of "strings attached"—I proposed at Phoenix, Ariz., in November of 1955 a third and final step: The creation of a World Energy Community to be underwritten by all the nations of the world for all the nations of the world.

The purpose of such an organization would be to put into effect by the united governments of the world a multilateral, multipurpose, multidynamic program utilizing principally the forces of atomic fission, applied solar energy, and perhaps at a later date, atomic fusion to balance in a master concept the world's economic needs with the world's means to fill those needs.

Senator PASTORE. How does that differ from the President's suggested international agency?

Mr. HOPKINS. I am coming to that in a moment.

In view of the present sophisticated economic-atomic aggression of the Soviet Union in what we believe to be the subversion of the moral values of entire peoples through material assistance, and our own disappointing failure to win easily and completely the hearts and minds of other nations, the urgency is even more apparent now than it was 2 years ago.

Therefore, I respectfully recommend again to the American Government that action be taken to adopt the concept of a World Energy Community as an integral part of President Eisenhower's currently developing atoms for peace program, the initial idea for which he broadly and courageously presented to the United Nations on December 8, 1953.

And, in repeating this recommendation I am fully aware of the Draft Statute of International Atomic Energy Agency prepared for discussion next September by a select group of 16 nations who happen to be, at this time, most immediately concerned and able to seize the early commercial advantages which may accrue.

But I should like to make the point that any such plan is more likely of success if promoted on the basis of a voluntary world information community dealing with multiple forms of energy, as I have suggested, rather than on the basis of a world control group dealing only with atomic fission.

Senator PASTORE. Is that the distinction?

Mr. HOPKINS. Yes; the control of the raw material and the fuel controls.

Senator PASTORE. Who would control that?

Mr. HOPKINS. The agency is set up for that purpose. They cannot control all of it, but a good deal of it. It is a donor arrangement there where they can turn it over. I would go for control groups on the regional basis, yes; and there might be 8 or 10 regions where you might want more control.

In order to implement such an international program which would not only automatically accelerate the present United States atomic energy program but, in my opinion, save it—I recommend to the Joint Committee, to the Atomic Energy Commission, and to the President of the United States a four-point atomic partnership program for initial and immediate action.

As a preface to my proposals, however, I think it pertinent to quote from page 325 of the background material for the report of the Panel on the Impact of the Peaceful Uses of Atomic Energy to this committee—this is to this committee and it is the so-called McKinney panel:

> The consensus of the discussion group was that potential buyers of power reactors in foreign countries could provide a substantial market for the United States atomic energy industry over the next decade provided restrictive governmental policies on the export of reactor fuel did not inhibit exploitation of the market.
>
> The group felt that a mass market for power reactors would probably not develop domestically for about 10 to 15 years, and that a substantial export market could provide an important bridge between now and the time the domestic market will develop. It was felt that this would provide a substantial impetus to the rate of reactor development within the United States.
>
> The consensus was that the foreign market would probably be more important initially than it would be a decade or so hence inasmuch as by then foreign producers will probably have entered the reactor manufacturing business in a substantial way and will be competing in the world market with the United States producers.

That report makes considerable sense to us, and it is preliminary to the plan that I wish to present.

Therefore, I now propose, one, that the United States Government state as a policy objective that every effort be put forth jointly, by those Government agencies concerned and industry, to the end that American industrial concerns may deliver and construct abroad by 1960 a specific number of power reactors—say 50—of electric generating capacity up to 20,000 kilowatts each; excepting only those types which the Atomic Energy Commission specifically classifies because of their unique military application.

There is no particular reason for the date except that it is nearby and a practical date. That is a little out of the portable class, but there could be some portables in it.

Second, that any foreign power which has a research bilateral or is eligible for one is also eligible to buy power reactors of the type described above.

The category would have to be arranged where the product is acceptable and desirable. There, your foreign governments are interested in a few different types. But in general, the 20,000 kilowatts, up to that, we think would be of interest.

Third, that the Government commit itself to provide liberal credit terms to facilitate the purchase of the reactors.

In a great many cases the credit would be very good, because power construction credit in the world has been very good indeed.

Four, that the other nations agree to cooperate in working out patent, insurance, and credit problems in time to accept delivery of the reactors.

Now, it is my conviction that if a policy generally along these lines is adopted we would achieve the following results:

1. Industry's energies and intentions would be channeled into a specific effort which—because it dealt with real reactors, real markets, and real customers—would cut through many of the legal, political, and commercial roadblocks.

2. The first practical demonstration, by any nation, of quantity production of power reactors could be achieved.

3. This policy, if implemented in time, would assure American leadership in world markets.

4. American foreign policy would be strengthened and the long-established United States policy in this field would be demonstrated tangibly.

5. The enormous economic and humanitarian benefits of atomic energy would be realized simultaneously not only in the underdeveloped nations, but in all nations in all parts of the world on the quickest possible timetable.

6. The orderly pursuit of research, development, and construction of new types of reactors at home by Government and by industry would not be impeded, but rather accelerated.

7. There would be developed, in the United States, the facilities for quantity production of small power reactors to supply domestic, industrial, civilian defense, emergency aid, and military needs.

8. The small reactor would present a practical and economical opportunity for providing actual experience and training for any region which expects to incorporate nuclear energy into its power networks. It would provide a similar opportunity for experience and training for domestic utilities serving small communities.

Further, quantity production of reactors would reduce costs not only of essential reactor components but of the price of the entire installed system.

It is my conviction, gentlemen, that an initial program for power reactors produced and marketed on this basis would prime the pump of our national industrial atomic-energy program.

And, once that program is activated and rolling along I think we may be able to leave its future strength and greatness to the traditional

American skills of management, and of production, and of marketing know-how.

That is very practical, and akin to what Dr. Zuckert said the other day, and I think Dr. Smyth, and I think Mr. McKinney. They touched upon this field. There were certain variations, but it was almost like collaboration, at least mentally.

Chairman ANDERSON. It happens that it is somewhat related, and it may not be exactly parallel, with the recommendation of the Joint Committee on Atomic Energy through its research and development subcommittee headed by Carl Hinshaw, in 1954. Their recommendation did not get printed until 1955, but they pointed out that the sending of these small reactors into other parts of the world would implement our foreign policy because while that type of reactor might not be commercially attractive in the United States, it might be extremely attractive commercially in other parts of the country.

Mr. HOPKINS. From 10, 12, or 15 mills even it would be very attractive in many places. Southern Italy for instance is one outstanding place.

Chairman ANDERSON. If the Government is going to send 50 of these reactors around the world, however, would not these reactors require some sort of a test, including an economics test in this country first?

Mr. HOPKINS. Yes, and it would give business to American industry, and not only that but American science and the Government laboratories would have to be in on it.

Chairman ANDERSON. I think it would do a wonderful thing for American industry, and for American inventiveness. I think that it would be a little bit like the uranium search that we had out in the Colorado plateaus.

Mr. HOPKINS. That was definitely subsidized, and heavily subsidized.

Chairman ANDERSON. Surely, and we did not have any interest in that, and all of a sudden it was wide open.

Mr. HOPKINS. New Mexico is loaded with it, much to your surprise and mine.

Chairman ANDERSON. Nobody would have believed that would have been true, that the State of New Mexico would certainly have reserves greater than all of the rest of all of that area. But it was discovered and it is there.

Mr. HOPKINS. It is the same theory.

Chairman ANDERSON. There are just as many gold mines to be found in this field if we once jar it loose, as there are in any other fields.

Mr. HOPKINS. You can figure about $250 a kilowatt for this, is that right, Dr. Zinn?

Dr. ZINN. It depends on the size of the plant. The small ones conceivably can be built for $350 and the larger ones will be less than that. All of the present estimates run down to about $220.

Mr. HOPKINS. The 20,000 kilowatt will be roughly $6 million, perhaps, would it not?

Dr. ZINN. Yes; 20,000 is probably a little small for some of the foreign markets, say in Japan.

Mr. HOPKINS. This is roughly the size. I do not mean 100,000 kilowatts. I do not think they would want them right now. They might want them later.

Chairman ANDERSON. Now, Mr. Hopkins what we have been discussing here at times has not been confined completely to the Gore bill but we have been discussing the possibility that there are types which are perhaps not the best first bets and they might be second best but they are well worth looking at. Dr. Zinn outlined 4 or 5 types of reactors that offer possibilities.

Now you would not send one of those to a foreign country and face the possibility that it might run away and cause trouble. You would not want to to have a very tragic accident some place. You would want it to be tested. Therefore if you are going to be in a position to do this by 1960 your target date I like because it happens to coincide with the end of the first period in Britain and the end of the first period in Russia.

Mr. HOPKINS. And the end of our planned program.

Chairman ANDERSON. The end of our first round in the reactor program. It is a fine date and it is a target that we ought to have. But if we are going to do that we ought to test some of these second bests that Dr. Zinn was referring to.

Mr. HOPKINS. Surely, and including perhaps gas-cooled reactors. We want to find out what there is in that.

Chairman ANDERSON. The testimony here reveals that during World War II, and before we were at the end of it, a recommendation came up to build a reactor, a small one, gas cooled, and a contract was arranged and $3 million was set aside for it. Monsanto was signed up for it to build it, and then it was stopped. Had we done it, with all of the mistakes that might have been inherent in that early design, we would be further along than we are today.

Mr. HOPKINS. It is a long look that we have to have in this business. It is short range and yet it is long range.

Chairman ANDERSON. In your own particular experience, you know very well that when your firm was asked to build a nuclear-powered submarine, you had not had too much experience with that particular boat.

Mr. HOPKINS. Nobody had, and we had to entirely engineer it.

Chairman ANDERSON. If you had to wait and wait and wait, that would have been the trouble.

Mr. HOPKINS. That is the trouble with the reactors, too.

Chairman ANDERSON. The *Nautilus* project is one of the most wonderful things that this country has done from an experiment standpoint.

Mr. HOPKINS. It has put the country on the map. We have to get closer to a lot of the nations of the world than the *Nautilus* will bring us but that can be done. We are really talking about $300 million if you want to limit it to about 50 reactors. A great deal of it would pay off, I think, and probably all of it, in time.

Senator PASTORE. Many representatives of private industry have appeared before this committee during the progress of these hearings, and joined in by the members of the Atomic Energy Commission, with the exception of one, taking the position that if we attempted to do more than private industry is presently doing in this research and development field we would actually be stepping on the toes of the various technicians and experts and physicists and mathematicians that we have, and that we would be overtaxing the personnel of the field and, in fact, retarding the whole program.

What is your opinion on that?

Mr. HOPKINS. I think that you would if you set up a huge program with the very large-scale reactors. I think that you would immediately divert a great deal of the attention of the AEC's engineers and scientists. I think Mr. Strauss made that point. They wanted more brains and not so much kilowatts.

But the program we have suggested here is a very moderate one, which I do not think would upset the technological area at all. In fact, I think they would have a lot of fun with it.

Senator PASTORE. If you built 20 or 50, of the 20,000 kilowatts, you would have the scientists with you but if you built 6 of the larger ones you would not?

Mr. HOPKINS. Well, you would parcel that out. Westinghouse and General Electric would both be interested in this, and Alcoa if they are not too tied up with the bigger one they are working on, and so forth.

The fact is, I believe, and I am not an engineer-scientist myself at all, as I have explained, and as has probably already been revealed, but I have been told by the experts that a program of this size with the smaller reactors would not involve much additional scientific research or engineering and so forth, than what they already have.

Dr. Zinn, and perhaps others here in the room, would be able to correct me on that. That is why we would limit it to the smaller group, and not interfere with the large-scale programs.

Dr. ZINN. Mr. Hopkins mentioned me, and I would like to make sure that this point is in: You are talking about 50 reactors of something like 1 million kilowatts total. The six reactors that the bill has in it are also supposed to be some fairly large number. It seems to me, roughly the drain on technical manpower, and so on, could be measured by the number of kilowatts that you are trying to build.

Perhaps there would be the added feature that the more division there is of this into separate enterprises, the greater the drain.

Mr. HOPKINS. That could be, the number of different types that you are working on.

Dr. ZINN. Not only types, but different projects of different companies.

Mr. HOPKINS. If you had duplicates, it would be much less demand on the technological and scientific resources.

Chairman ANDERSON. I would like to ask Dr. de Hoffman if you agreed to that?

STATEMENT OF FREDERIC DE HOFFMAN, VICE PRESIDENT OF GENERAL DYNAMICS CORP.

Dr. DE HOFFMAN. Rather than agree or disagree, I think what could be done is to try to use technical manpower that does exist, and not by any control—but purely by the means that are well known—in a more effective manner. I feel very strongly, for instance, that cooperation between physicists and engineers can be improved. Now, in certain places there is very good cooperation. Dr. Zinn—in this room—knows how important this is, and other AEC laboratories are also examples of how very well engineers and scientists can cooperate in certain laboratories but, by and large, this cooperation has not caught on.

I think that in order to use industry effectively and in order to really get companies to use their scientific personnel in an effective manner,

is is very essential that we do get this cooperation between the separate disciplines of chemists, engineers, physicists, metallurgists, and so forth. I believe that if you do get this, the current manpower can go a lot further and that you can do a lot more with the groups which are in existence.

I think that there is a great deal of overlapping effort going on, by people reading each others papers rather than forming into effective new task-force groups. Look at the early days of the Manhattan project, and look, relatively speaking, at the small number of men that were able to carry ideas forward in a matter of months, compared to the lengths of time it takes now. I am aware of the fact that as technology gets more complicated, things traditionally take more time. But I am convinced some of this time can be saved even with the current personnel shortage. I hope the effort in our company in the direction of more effective use of technical manpower in industry will help point the way regarding the scientific manpower problem.

STATEMENT OF JOHN JAY HOPKINS, CHAIRMAN OF THE BOARD AND PRESIDENT OF THE GENERAL DYNAMICS CORP.—Resumed

Mr. HOPKINS. I have mentioned I did not think that there should be any quarrel between public ownership and private ownership.

Senator PASTORE. That is a specific, yes; but I am trying to get down to the base of it.

Mr. HOPKINS. I am told by my advisers and I have to have them, as you know, plenty of them, that if you have these six big reactors, they would draw a great deal of the attention from technologies and people and so forth. They tell me that you would likely build something big that would be obsolete pretty soon.

Senator PASTORE. I realize that, but you see we do not hold a monopoly in this entire field, and now you are suggesting that we build these 20,000-kilowatt reactors.

Mr. HOPKINS. He wants to get something done as I understand it.

Senator PASTORE. Not only that, but he wants to perfect this art of reducing the economic cost and to make it more competitive with the use of conventional fuels.

Now, if we begin to build 50 of the 20,000-kilowatt reactors, at the cost of, let us say, 15 mills or whatever the case might be, which would have to be pretty high in the beginning, you say there are certain strategic parts of the world where they could be utilized as of tomorrow. That is a wonderful idea.

But let us assume that Russia the next day comes out with an idea where they have reduced it by 200 or 300 percent only because they are on a crash program and we are not. Then how are we going to save face in the eyes of the world?

Would not we be run right off the market, even with 50 of the 20,000 kilowatts? I think essentially here you have to be on a crash program to reduce the cost. The only way you can do it is by getting into big reactors.

Now, I think it is desirable in the meantime to run this other program of 20,000-kilowatt reactors but if tomorrow another nation comes along, either the United Kingdom or Russia, with the same reactor and shows that theirs is much cheaper to run and more economical to

run than ours, my goodness, where would we be in the eyes of the world?

Mr. HOPKINS. I would go along with that. I am not arguing against the building of big reactors. These 50 would not be done all at once, and you would modify your program if you found there were eventualities to face of that kind.

Senator PASTORE. With an effort being made by private industry of only $250 million in this entire field, $250 million to me is a very small amount when we consider the magnitude and the vastness of this project and the potentialities of it. As a matter of fact, we will change the entire mode of living of the entire world. You have more or less pointed it up by your suggestion that we ought to begin to win the hearts of people by getting these reactors built and we ought to begin to sell them and distribute them throughout the entire world.

Mr. HOPKINS. In your absence, Senator, in the early part of this, there was a small defense of American industry. I think that they have done a good job under all of the circumstances but they can do a much better job. Actually, American industry was not invited into this situation until the amendment of the McMahon Act, until 1954.

Senator PASTORE. I realize that completely.

Mr. HOPKINS. That is just a brief period of 2 years.

Senator PASTORE. You have to admit that while there are limitations upon industry, the fact of the matter is that not too much progress has already been made.

Mr. HOPKINS. It is a little unfamiliar to a great many of them, for one thing.

Chairman ANDERSON. They have been in this program a long time. General Electric has built plants.

Mr. HOPKINS. For the Government, but I think Senator Pastore was speaking about industry very generally there, and you did not mean specifically Westinghouse and General Electric.

Chairman ANDERSON. Private industry in America has dedicated from the testimony that has been brought out at these hearings about $250 million to be spent over a period of 5 years. Now, you divide $250 million by 5, and you have about $50 million a year. Maybe it is a little better than that.

Mr. HOPKINS. But it is increasing.

Chairman ANDERSON. Do you think that is a sufficient effort in this particular field on the part of this Nation? Let us forget private industry and Government.

Mr. HOPKINS. That is right.

Chairman ANDERSON. We have to put this whole program in proper focus.

Mr. HOPKINS. It is not good enough, you are absolutely right. I have been urging this for 2 years.

Chairman ANDERSON. Now, Senator Gore comes along and says that in addition to what private industry is doing, because we realize their limitations, we ought to build on our own. This will have to be done by private industry because it will be done on a contract basis. Industry comes in here and says, "Now, if you do that, you are going to usurp all of the talent that we have now engaged in this particular effort on the part of private industry."

I cannot take that too seriously.

Mr. HOPKINS. Personally, and as an industrialist, I would go along with you, Senator.

Chairman ANDERSON. I wanted you to say that.

Mr. HOPKINS. But for some reason or another, the people that we are told are experts in this matter feel that it might divert us.

Chairman ANDERSON. It is perfectly obvious that if you get a whole big program, 2 or 3 people who have it now cannot hold it.

Mr. HOPKINS. That is right.

Chairman ANDERSON. The point is also made, and it was made this morning in testimony, that the private electric utilities invested $4.3 billion in new conventional facilities in 1955. They could invest $4 billion, and they had all of the supervisory capacity and they had all of the engineering people and all of the draftsmen to do that but they could not spend $50 million without just tearing the place all to pieces. It does not make much sense.

Mr. HOPKINS. A lot of it is because there has been too much talk in this country about uneconomic performances, and so forth. We do have, as heads of companies, the responsibility of not being too uneconomic in any particular business; otherwise you are going to the wall.

Chairman ANDERSON. If the Atomic Energy Commission gets ready to let a contract on the Brookhaven type of reactor, there are 12 companies ready to bid and all of them able to do it. But if you want to build 1 more in a foreign country under the Gore bill, there is not a soul that can touch it for 5 years to come.

Mr. HOPKINS. Dr. DeHoffmann asked me to mention that our company was the first one to begin a $10 million program about a year and a half ago with our own money entirely, to set up a basic research laboratory. It has been done now since by several more.

Chairman ANDERSON. I think it was a very progressive thing.

Mr. HOPKINS. Ford has just announced a large program. General Electric is announcing one in California.

Senator PASTORE. We know that the Russians are in this thing up to their ears. There are a lot of people, and they have just as much right to their opinion as we have to ours, who say that we overestimate the progress that Russia is making. I think sometimes it is good to overestimate because that serves as an inspiration and an impetus to us to get busy with our own job.

But after all, the Cisler group which involves about 26 companies, and represents about 40 percent of the entire electrical power of this Nation, are building one breeder-reactor. If we take that as a measurement, 100 percent would mean two and one-half reactors. Now, should that be America's program?

Mr. HOPKINS. No, it should not. We are putting our own money into it, and one thing I will say about Consolidated Edison is that they marched up to it, in spite of the fact that they had people who criticized them, and said, "You are talking about building a 15 or 20 mill plant or something like that, when you can get your power, all you want, right now for around 4 or 6 mills."

Dr. ZINN. They testified this morning.

Mr. HOPKINS. I know it is rapidly coming down. But I think that that is what you can expect will happen.

Chairman ANDERSON. I am happy to put in the record that I think this statement is a very thoughtful and good statement and we are

happy to have it. We are extremely happy that your company has put a large amount of money into research and that you have gone after this intelligently, and, I think, in a driving fashion. I hope some of the good examples you have will be picked up by other parts of the industry.

Mr. HOPKINS. I, for 3 years, tried to wake up industry wherever I have gone, and I think there are some signs of them waking up in the past year.

Chairman ANDERSON. Thank you very much.

Mr. HOPKINS. Thank you, gentlemen.

Chairman ANDERSON. In order that the record may be complete, I want to add a number of things to it that have come in to us.

First of all, there is a telegram from the New England Council, signed by Walter Raleigh, executive vice president.

A telegram from the Connecticut Chamber of Commerce filed with the Joint Committee; a statement to be filed with the committee of its opposition to S. 2725.

A letter from the Dow Chemical Co., giving its views; I am very much interested in this one paragraph saying:

> At least seven new and daring experiments are needed at really high temperatures, high specific power and with continuous separation of fission products, for testing out the maximum of simplicity, breeding gaing, self-regulation and safety * * *.

I think that is a very good statement from them.

We have a statement from Fred Hall, Governor of Kansas, expressing his regrets that he could not make a personal appearance before the committee, but stating that he feels he should wire his concern over the pressing need to speed atomic power research, and secure America's leadership in this vital field.

A letter from the University of Illinois, college of commerce and business administration, giving various observations with reference to the bill. It is actually the personal opinion of Horace M. Gray, professor of economics.

A letter from Herbert D. Vogel, of the Tennessee Valley Authority, enclosing the TVA's views on acceleration of the civilian reactor program.

A letter from the Bonneville Power Administration, by E. C. Starr, chief engineer.

A statement from the Northwest Public Power Association, Inc., Vancouver, Wash., presenting its views.

A cablegram from Oslo, from T. Keith Glennan, former member of the Commission, and a member of the panel which gave a fine report.

A wire from North American Aviation Corp. of Los Angeles, Calif., the atomics international division.

A statement from Joseph V. Santry, chairman of the board and chief executive officer of Combustion Engineering, Inc.

They will all be set forth in the record at this point.

(The letters and statements referred to follows:)

BOSTON, MASS., *May 29, 1956.*

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
United States Senate, Washington, D. C.:

The New England Council which was established by the six governors of the New England States and which represents 3,300 business organizations and Government agencies expresses conviction that if a proper Government insurance program for nuclear powerplants is adopted that private business will make adequate progress in developing power reactors for commercial use. We strongly object to any proposals which would put the Federal Government further into the power-generating business.

WALTER RALEIGH,
Executive Vice President, the New England Council.

HARTFORD, CONN., *May 28, 1956.*

JAMES T. RAMEY,
Executive Director, Joint Committee on Atomic Energy,
Senate Office Building, Washington, D. C.:

The Connecticut Chamber of Commerce will file with the Joint Committee on Atomic Energy its opposition to S. 2725. This statement is in process of being completed and will be mailed to you today.

WILLIAM B. CAFKY,
Executive Vice President, the Connecticut Chamber of Commerce.

STATEMENT OF THE CONNECTICUT CHAMBER OF COMMERCE IN OPPOSITION TO S. 2725, PRESENTED BY WILLIAM B. CAFKY, EXECUTIVE VICE PRESIDENT

Mr. Chairman and members of the committee, the Connecticut Chamber of Commerce wishes to record its opposition to S. 2725 which would authorize the Federal Government to build and operate atomic-energy plants for the production of nuclear electricity.

The entrance of the Federal Government into this field of endeavor will not only be expensive to the taxpaying public but it will expand Government operations in private enterprise which is contrary to recommendations which have been made by practically all business organizations, the Hoover Commission, and others, to the Congress and in direct opposition to the taxpaying industries of the Nation.

Upon the enactment of the Atomic Energy Act of 1954, Connecticut enacted legislation designed to support and regulate the development and utilization of atomic energy for peaceful purposes.

Every effort has been made by business and industry in this State to develop and advance the production of nuclear electricity. Several research facilities have been developed within this State for the purpose referred to and much progress has been made in this field by private business and from private funds. The membership of the Connecticut Chamber of Commerce is composed of all important segments of industry and business in this State and we do not find any sentiment among our membership for the entrance of the Federal Government into a field of operation which we believe should be open solely to private industry.

In support of our contention that private industry should be permitted to develop atomic energy we cite the following:

One of the most important factors in Connecticut's future is the effect of the mighty atom. There is no doubt that the atomic age is close upon us. Fortunately, Connecticut with its Yankee ingenuity and versatility in adopting new methods and industries is participating in atomic development. According to the Atomic Energy Commission, in early 1955, approximately 4,000 workers in the State were already employed in atomic-energy projects, and 33 atomic contracts with an estimated worth of $25 million had been awarded to business firms and research centers in Connecticut. A publication by the same agency revealed that radioactive and stable isotopes were in use in 31 corporations, 11 hospitals, 5 colleges, among others in Connecticut.

HARTFORD RESEARCH FACILITY TO DEVELOP ATOMIC-ENERGY AIRCRAFT ENGINE

In addition, Congress approved, in 1954, the $30 million Hartford Research Facility to be located in the Maromas section of Middletown and operated by the Pratt & Whitney division of United Aircraft Corp. for the continued development of the atomic-energy aircraft engine. Construction on the new research facility started in August 1955, which, when completed, will employ some 3,000 workers.

LINEAR ACCELERATOR AT YALE UNIVERSITY

Furthermore, 1 of the 2 heavy-particle linear accelerators for nuclear research in this country is located at Yale University. The initial appropriation by the Atomic Energy Commission for the Yale linear accelerator was $1,200,000. Such an accelerator, according to reports, will produce particles with energy of more than 100 million electron volts. The laboratory was completed in 1955 but assembly of the accelerator will take another 2 years.

ATOMIC SUBMARINES

The Electric Boat division of General Dynamics Corp. in Groton, manufacturer of submarines for the United States Navy, produced the first atomic-powered submarine, the *Nautilus*, at a cost, exclusive of the atomic reactor, of $30 million. The *Nautilus* was launched in January 1955. A second atomic submarine, the *Sea Wolf*, was built at Groton and was launched in July 1955. Besides having a third atomic submarine under construction, Electric Boat was given contracts by the Navy Department for two more in October 1955.

It is also noteworthy that the Electric Boat division started construction in the summer of 1955 on a $1 million research and development center at the plant in Groton.

A RESEARCH REACTOR AVAILABLE FOR CONNECTICUT INDUSTRY

The American Machine & Foundry Co., which has research facilities in Greenwich and Springdale, Conn., will build a research reactor costing between one and one and a half million dollars. This industrial research reactor, planned under private ownership and operation, will be located in the New York area but will be available to Connecticut industry. It is said that this type of reactor is the pilot plant for future development in all fields.

YANKEE ATOMIC ELECTRIC CO.

One of the most important considerations for Connecticut is the possibility of generating electric power from nuclear fission since the State does not have the resources either in water or coal that certain other States do. Therefore, it is significant that the Yankee Atomic Electric Co. was formed in 1954 by 3 Connecticut utilities—the Connecticut Light & Power Co., the Connecticut Power Co., and the Hartford Electric Light Co.—in cooperation with 9 other major New England utility corporations.

The Yankee Atomic Electric Co. applied in early 1955 for a license from the Atomic Energy Commission to construct a nuclear powerplant in Rowe, Mass. The original proposal of the Yankee Atomic Electric Co. was rejected but a revised plan was accepted by the Atomic Energy Commission as a basis for negotiations in February 1956. The revised proposal calls for a pressurized-water reactor plant with a capacity of 135,000 kilowatts, costing around $35 million. Since under the terms of the Atomic Energy Act of 1954, New England, as a high-cost power area, is entitled to preferential treatment, it seems likely that negotiations will not be long delayed.

According to the experts, the production of electric energy from atomic sources will be more costly, at least for the immediate future, than that produced from conventional fuel-burning plants. The major advantage of early participation by the utilities in the atomic-energy field may well be to help develop the general knowledge and skills which will act as a stimulus to New England's industrial growth.

STATE COORDINATOR OF ATOMIC DEVELOPMENT ACTIVITIES

In order to coordinate development and regulatory activities relating to the peaceful uses of atomic energy, a law was enacted by the 1955 Connecticut Gen-

eral Assembly. Under this legislation, the laws and regulations of the State covering such subjects as working conditions, transportation, insurance, and conservation of natural resources would be adapted to meet the new conditions presented by the atomic age, at the same time protecting the public interest.

According to the statute, the Governor shall appoint a citizen of the State to serve as coordinator of atomic development activities. He shall receive no salary but shall, unless he holds a salaried position in the State service, be paid $20 per day for each day actually devoted to his duties as coordinator, and shall be reimbursed for his necessary expenses. In January 1956, Governor Ribicoff appointed Henry M. Marx, of Greenwich, an attorney and special counsel for the General Dynamics Corp., as atomic-energy coordinator for Connecticut.

The sum of $5,000 was appropriated to carry out the purposes of the act.

COMBUSTION ENGINEERING, INC., BUILDING ATOMIC PLANT

Combustion Engineering, Inc., of New York, announced plans in late 1955 to construct a $10 million factory in the town of Windsor to build and reprocess nuclear reactors. This corporation entered the field of nuclear-power development in 1946 and its output has included reactor vessels and other components for the atomic submarine *Sea Wolf*. Combustion Engineering, Inc., has plans which include the possible building of a test reactor for use in research and facilities for the reconditioning of spent-fuel elements. It is interesting to note that, according to the company, among its reasons for coming to Connecticut is the availability of technical schools in this area.

In January 1956 the company was already operating in rented space in Windsor. Meanwhile, the site was being cleared and construction activity started.

In conclusion, it is our contention that S. 2725 merely creates another Federal power agency which would be endowed with all the special tax privileges and subsidies now enjoyed by other Federal power businesses. We submit that the creation of such agencies are absolutely unwarranted in any area of the Nation because private power companies have demonstrated their willingness and their ability to supply all of our domestic power needs.

THE DOW CHEMICAL CO.,
Midland, Mich., May 21, 1956.

Hon. CLINTON P. ANDERSON,
Chairman, Committee on Atomic Energy, Washington, D. C.

SIR: In response to your invitation, I should like to give you my personal observations concerning the proposals for accelerating the civilian reactor program in this country. I share with your committee the desire to bring about the earliest possible commercial utilization of nuclear energy.

A great deal of the highest caliber effort has gone into these objectives. All of the projects currently underway for the production of power, though very likely to operate satisfactorily, are unlikely to show commercially competitive costs. It is hoped that out of these major efforts will grow a realization that one cannot legislate or buy really new things. They must be created.

This leaves us with a major development to be made in a field in which private incentive has been lost by treating it so differently from other developments that have come to make our country great, such as railroads, aviation, radio, television, and modern farming.

When a breakthrough will come it will be as a result of treating this new source of energy as a new jewel having to be cut according to its own crystal structure, not imitating an old form. All sorts of old practices, in the field of law, politics, and labor relations, as well as boundaries between industries, are likely to be left behind when this breakthrough finally comes.

The low cost and weight of uranium and thorium fuel should find part of the driving force in new services and products. It should reduce the need for expensive new high-line distribution systems by distributing automatic power plants like substations. Nuclear power should provide byproduct heating and cooling for the local areas, chemical processing for new products, and fission product heat energy for propelling airplanes and the like. While spare neutrons

from the breeder reaction could be used to produce additional enriched fuel, they should be used to produce radioactive isotopes of higher value, such as tritium, for which there may be many applications. The capacity of such units may be much less than those generally considered economic now, but the versatility will be astonishing.

Nothing that we can do in the direction of spending more money on more nuclear plants, such as one can build now, will change this picture. We need more daring, and new simplified versions of better reactor concepts, before we will be out of the woods. This type of research is difficult to do when there is no private incentive. It is also impossible to do this any place as a goldfish bowl project. There must be the freedom to fail or gain.

At least seven new and daring experiments are needed at really high temperatures, high specific power and with continuous separation of fission products, for testing out the maximum of simplicity, breeding gain, self-regulation and safety. These tests could be made at such locations as Los Alamos and the Idaho reactor test sites. This should be pushed with the speed and simplicity of the Borax experiments.

Respectfully yours,

JOHN J. GREBE,
Director, Nuclear and Basic Research Department.

TOPEKA, KANS., *May 24, 1956.*

Senator CLINTON ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Senate Office Building, Washington, D. C.:

Previous commitments prevent personal appearance before your committee. However, I feel I should wire my concern over the pressing need to speed atomic power research and secure America's leadership in this extremely vital field. Large power units are receiving attention of major power companies, but development of small or medium-size reactors to test different techniques under actual working conditions is where we lag. We must get beyond the laboratory stage. We should utilize the partnership principle to stimulate all possible segments of electrical industry, whether municipal, rural electric, or private utility. This will benefit our domestic economy as well as national defense and foreign relations. I am confident Kansas rural electric system will welcome legislation making it possible for them to build small or medium-size experimental reactors as their contribution to progress. They have statewide power study underway now. Let's provide more interest in America's atomic power development by stimulating greater participation of local enterprises in small or medium atomic plants.

FRED HALL, *Governor of Kansas.*

COLLEGE OF COMMERCE AND BUSINESS ADMINISTRATION,
UNIVERSITY OF ILLINOIS,
Urbana, Ill., May 21, 1956.

Senator CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Senate Office Building,
Washington, D. C.

DEAR SENATOR ANDERSON: In connection with the hearings now underway before your Joint Committee on the Gore bill (S. 2725) I should like to submit the following observations for your consideration. In doing so, I speak as a professional economist with many years experience in the areas of monopoly, public utilities, natural resources, and public control. I have followed closely the evolution of congressional policy in the field of atomic energy since 1945 and, hence, am interested in the Gore bill because of the principle at issue. Having no personal interest at stake, I trust that my views can properly be regarded as reasonably objective and nonpartisan.

To evaluate the Gore bill one should, I think, view it in historical perspective. When, in 1946, the McMahon Act was under consideration the private electric power industry offered no significant challenge to its passage. It was the view of the industry, as evidenced by many public pronouncements of its leaders, that atomic power would never, or at least in the calculable future, be

competitive with electric power from conventional sources. Hence, they manifested little interest in its potentialities and were generally indifferent as to how it might be controlled. For some 8 years (1945–52) they persisted in this attitude and did nothing by way of scientific and technical research to explore the possibilities of atomic power production. In short, so long as atomic power posed no likely or immediate threat to their existing monopoly status the private electric utilities were indifferent to its development.

It was only after further research, under Government auspices and at the taxpayer's expense, had brought atomic power to the verge of practical realization that the electric power industry began to manifest alarm over the potential threat to its monopoly position. It was conceivable that under a liberal interpretation of the McMahon Act the Federal Government might, in the not too distant future, actually produce electricity by atomic reactors and distribute it to the public through nonprofit organizations. If this danger were to be averted it was imperative that the act of 1946 be amended to prohibit Federal atomic power production and to permit private exploitation of this new power resource on a monopolistic, subsidized basis.

Accordingly, in 1952–53, the private power monopolists, and their allies, organized a massive political and propaganda campaign to seize control of this extremely valuable portion of the public domain—a domain created solely by the contributions of taxpayers and to the development of which the electric utilities had contributed nothing. A great hue and cry was raised against the McMahon Act. It was, so the hucksters proclaimed, monopolistic, socialistic, unprogressive, restrictive, and hostile to free enterprise; it excluded private initiative and private investment, thereby depriving the people of the manifold blessings certain to accrue from private development. The propagandists portrayed the electric power monopolists as straining, like Chiang Kai-shek, to be "unleashed" so that they might invest billions, immediately and without costs to the taxpayers, in the construction of atomic powerplants.

Unfortunately, the administration and a majority of the Congress succumbed to this propaganda and in the act of 1954 foolishly yielded to the clamor and false promises of these selfish interests. The result was a huge giveaway of the public domain—probably in terms of potential magnitude and untoward social consequences the biggest giveaway in American history. As Walter Adams and I demonstrated in our recent book—Monopoly in America: The Government as Promotor (Macmillan, 1955)—the Atomic Energy Act of 1954 laid the foundations for what may well become a powerful and oppressive monopoly over the vital energy supply of the United States.

This mistaken policy, in my judgment, was due primarily to the failure of the Congress to comprehend clearly the nature, psychology, and economic strategy of private monopoly, particularly when it enjoys the special privilege of legitimacy as the chosen instrument of society for the effectuation of some public purpose. Such monopolists invariably presume upon their privileged status to dictate to the state, to subordinate the state to their service, and to restrict production, suppress competition and control alternative technologies in the interests of maximizing profit and maintaining monopoly power. It is now perfectly clear, as it should have been from the first, that this was the grand strategy of the electric utilities in their 1954 campaign to revise the McMahon Act. They did not seek to develop atomic energy, but rather to preempt it, control it, preserve their monopoly status and preclude public development. When and if atomic power should become sufficiently profitable, or heavily enough subsidized, they would integrate it with conventional power and thus maintain their monopoly control.

The lack of progress in the 2 years that have elapsed since the act of 1954 was passed, as demonstrated in hearings before the Joint Committee, indicates that this diagnosis is correct and realistic. While Russia, Britain, Canada, and other countries push ahead under forced draft, the United States, with its far greater resources, lags behind, stalemated in the atomic race by the baneful spirit of private monopoly and the supine, do-nothing policy of the Federal Government. The Government, abdicating its responsibility, insists that atomic power be developed by private monopoly; but the latter, pursuing its selfish interest and capitalizing on the self-imposed dependency of the Federal Government, insists on further privileges, immunities, and subsidies as a precedent condition to its active participation in a developmental program.

For example, the private power monopolists insist on accelerated tax amortization, further concessions in respect to patent rights, exclusive ownership of atomic fuel, governmental subsidization of research, technical development, and

fuel supply, the public underwriting of risks, public contributions of capital for reactors, the right to shift developmental costs to consumers, and immunity from the Holding Company Act of 1935 (S. 2643). Seemingly, there is no limit to such demands other than the avarice and arrogance of those who make them. Atomic power, if developed under such conditions, would be the most heavily subsidized industry on record. Taxpayers and consumers would bear all the costs while private monopolists would garner the profits. It is farcical to speak of such a system as free private enterprise.

The gravest and most fatal defect in the act of 1954 is the prohibition against Federal construction and operation of atomic powerplants. This provision places the Federal Government in a position of abject dependence and utter helplessness vis-a-vis the private power monopolists. It can neither act itself nor compel them to act; all it can do is bribe them. The Gore bill (S. 2725) would rescue the Federal Government from this disgraceful and irresponsible state of dependency by authorizing it to construct six large atomic powerplants and to dispose of the output in accordance with established national power policy. It would terminate the present dependency on private monopoly as the chosen instrument of public policy, eliminate the vicious subsidy system, insure all-out development of atomic power and serve the general welfare instead of private profit. If the hands of the Federal Government were thus unshakled the private electric power industry would, I predict, suddenly and miraculously discover that it, too, could develop atomic power without the special privileges and subsidies it now demands. There is, after all, nothing which so stimulates creative energy and enterprise as wholesome competition.

In the great debate of 1954, as you will recall, many Representatives, Senators, and public-spirited citizens called attention to the potential dangers of monopoly and fought hard to incorporate in the act precautionary safeguards, one of which was the principle now embodied in the Gore bill. Unfortunately their counsels did not prevail. The events of the past 2 years, however, now demonstrate that their premonition was correct and that it was a grave mistake to rely on private monopoly for the development of atomic power. The testimony before your Joint Committee of such distinguished men as Murray, Olds, Reuther, Grahl, Ellis, Radin, and others confirms this conclusion. By passing the Gore bill Congress can eliminate this defect in the act of 1954 and free the Federal Government to assume positive leadership in the great and urgent task of developing atomic power for the general welfare of our own people and of all mankind.

Very sincerely yours,

HORACE M. GRAY,
Professor of Economics.

TENNESSEE VALLEY AUTHORITY,
Knoxville, Tenn., May 18, 1956.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Senate Office Building, Washington, D. C.

DEAR SENATOR ANDERSON: This is in response to your telegram of May 10 regarding hearings on proposals for accelerating the civilian reactor program in this country.

We have no immediate plans for the construction of a reactor project to meet either in whole or in part the need for additional electric generating capacity in the Tennessee Valley region. However, as you suggested, we are enclosing 25 copies of a statement which summarizes our views as to the importance of a vigorous prosecution of the civilian reactor program and the most effective way of accomplishing this.

It would not appear to be necessary for TVA to appear at the hearings.

Sincerely yours,

HERBERT D. VOGEL,
Chairman of the Board.

TVA VIEWS ON ACCELERATION OF THE CIVILIAN REACTOR PROGRAM

TVA shares the general conviction that the early development of economic nuclear power is of great national importance. This feeling is based on several considerations: The promise of ultimately lower power costs, the need for long-range conservation of coal and petroleum reserves; the importance to our national

economy and national defense of a plentiful power supply; and the desirability of maintaining our technological and industrial leadership among the nations of the world.

Even though our Nation is in the fortunate position of having ample, low-cost fuel resources for immediate future needs, the prospect of ultimately reducing power production costs should be recognized as an important incentive for expediting the development of nuclear power. With a rate of power production in the United States that will probably be reached before 1956, each tenth of a mill per kilowatt-hour change in average costs would amount to $100 million a year. Availability of low-cost power throughout the Nation may become possible once the low-cost potentialities of nuclear power have been realized. Lower rates and higher use imply an ever-increasing market for electrical equipment and appliances—an important factor in industrial growth.

These fact and prospects argue for expediting nuclear power development but not necessarily for building uneconomical reactors—and any reactors built now can be expected to produce relatively uneconomical power—of large size and in large number. The justification for early construction of a number of large reactors may be more likely to be found in considering our international position rather than our immediate national domestic requirements. Our ability to develop military applications of atomic energy has been thoroughly demonstrated to the world. It is not obvious to the layman why similar demonstrations of economic power production are not underway. Early evidence of our ability to develop peaceful applications of nuclear power may well prove important to the maintenance of our technological and industrial leadership among the nations of the world. The experience to be gained in such a program would be very helpful in strengthening the competitive position of American industry in world markets for nuclear power equipment. The development of useful reactors, even though the first ones were uneconomical from the standpoint of competitive power costs in this country, may be of great value to friendly nations in the development of their natural resources and industries, and in improving the living standards of their people.

It seems clear that the strongest incentives for rapid development of nuclear power are primarily related to various national interests rather than the particular interests of individual companies or of the industrial community. The development effort probably will be long and certainly will be costly; it will involve great financial risks with little prospect of early profits. It is hardly to be expected, under these circumstances, that a comprehensive nuclear power industry will soon be developed primarily at the expense of companies having due regard for the interests of their stockholders.

We cannot escape the conclusion that the Federal Government must, in one way or another, bear the bulk of the tremendous expense of civilian nuclear power development, just as it bears the cost of development of military application.

If civilian power reactors are to be developed as quickly as possible, the Government must vigorously prosecute the program. It should undertake the responsibility for seeing to it that everything is done that should be done, that everyone participate who should participate. This suggests that the Government must accept the primary responsibility for planning and building some demonstration projects. The job of developing specific pieces of equipment, such as pressure vessels, valves, pumps, and heat exchangers could and should continue to rest with private equipment manufacturers, but the Government should take primary responsibility for selecting the most economical and promising reactor types for which development should be expedited, for planning the research and development work required, and for arranging for this work to be conducted promptly and carefully, all with the objective of constructing practical civilian power reactors as promptly as possible. The knowledge gained would be in the public doman and private operators could be expected to undertake the construction of additional reactors just as soon as the information developed through the Government effort indicated that economical reactors were in clear prospect. The sooner some demonstration projects are under way, the sooner individual initiative will come into full play to achieve the utmost improvements in design and construction.

If AEC were to build a limited number of large-scale nuclear electric plants, TVA believes that its power system is readily adaptable to serving as a test system for one of such plants. It is the largest integrated power system in the country, with a capacity approaching 10 million kilowatts. A system of this magnitude can readily absorb the variations in electricity production which

should be expected in the case of a large experimental plant. Having a load which is now growing at the rate of about three-fourths of a million kilowatts each year, the TVA system would provide a market for the output of a large nuclear powerplant, and would present an opportunity to demonstrate the prospective economies of such a reactor.

TVA has long had an interest in the development of nuclear energy for civilian power applications. Following its participation in some of the Atomic Energy Commission's earlier reactor development projects, TVA in 1953 entered into a study agreement with the Commission and has since been examining possible applications of nuclear power to the TVA system. We stand ready and willing to cooperate with the Commission in order to achieve the utilization of nuclear energy to help meet the rapidly growing electricity demands in the Tennessee Valley region and to contribute toward other objectives of nationwide importance.

DEPARTMENT OF THE INTERIOR,
BONNEVILLE POWER ADMINISTRATION,
Portland, Oreg., May 21, 1956.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
United States Senate, Washington, D. C.

MY DEAR SENATOR ANDERSON: Reference is made to your telegram of May 10, 1956, regarding the hearings beginning May 23 on proposals for accelerating the civilian reactor program. I should like to resubmit a part of my statement in a letter addressed to you on March 6, 1956, as follows:

"The use of atomic energy for the generation of large blocks of power is of great interest to us as a transmission and marketing agency, and we are sure it will ultimately have a profound influence on the development and operation of large power systems. Our interests, as well as those of other utilities in the Pacific Northwest, however, tie in more closely with the long-range development rather than any immediate large-scale application of atomic energy to the generation of electricity. We are following this development very carefully, as we believe nuclear power is destined eventually to become an important supplement to the large hydro resources now supplying practically all the electric energy used in the Pacific Northwest.

"If all major hydro potential in this region is developed as needed, it will supply the estimated energy requirements to about 1975. Due to economic feasibility and conflict of interests, such as migratory fish, navigation, and irrigation, some of the hydro potential may never be developed, and some sites may be delayed for many years. If the projects now considered to be economically competitive are all developed when required, they will supply the estimated needs of the region to between 1970 and 1975. A certain amount of thermal firming capacity is desirable and should be in operation before that time.

"Since the Pacific Northwest does not have large reserves of oil or gas, and the coal reserves are of relatively low quality, fuel cost for conventional thermal electric generating plants will be high, probably not less than 30 to 40 cents per million B. t. u. even in large quantities. We are convinced that the cost of producing electric energy through the use of nuclear fission will gradually come down, while the cost of hydro energy will continue to increase after the low-cost sites have been developed. It appears at present that incremental hydro costs may reach the conventional-thermal level in this area in 15 to 20 years. By that time several generations of power reactors will have been constructed and nuclear power should be competitive. We should then be prepared to move vigorously toward its adoption."

I should like to add to our previous statement, because of our essentially long-range interest in nuclear-power development, that very strong emphasis should be placed on the major power reactor experiments. That is, reactor experiments based on the most promising concepts and utilizing full-scale components where such components are new, critical, and peculiar to the nuclear-power art. Typical items falling in this category are fuel elements, moderator and structural components, control rods and systems, pumps and valves for handling radioactive substances at high temperatures and pressures, and unique heat exchangers and heat exchange systems. The objective of these experiments is to develop components and materials that can be assembled into full-scale plants with a minimum of further development. This experimental program

should be accelerated as much as possible and should be multilateral in its approach.

When the time arrives for the assembling process to proceed, based on successful and economical component development, it should go forward without delay, emphasizing the then most promising concepts or combinations. Some one or more of our major reactor experiments may now have reached this stage—they should be examined critically.

Sincerely yours,

E. C. STARR, *Chief Engineer.*

NORTHWEST PUBLIC POWER ASSOCIATION, INC.,
Vancouver, Wash., May 21, 1956.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Capitol, Washington, D. C.

DEAR SENATOR ANDERSON: Please find attached the statement from the Northwest Public Power Association relating to the construction of six Federal atomic power stations as outlined in proposed legislation by Senator Gore.

May I request that this statement be included in the hearings record.

Respectfully,

GUS NORWOOD, *Executive Secretary.*

STATEMENT OF NORTHWEST PUBLIC POWER ASSOCIATION, VANCOUVER, WASH., RELATING TO CONSTRUCTION OF SIX FEDERAL ATOMIC POWER STATIONS

My name is Gus Norwood. I serve as executive secretary of the Northwest Public Power Association comprising 101 consumer-owned electric distribution systems in Alaska, Montana, Idaho, Oregon, and Washington, including rural electric cooperatives, municipal electric distribution systems and utility districts serving about 1,800,000 people with electricity.

In behalf of the Northwest Public Power Association I wish to testify favorably on the proposed legislation by Senator Gore to authorize construction of six Federal atomic energy generating stations. As long ago as November 20, 1953 the board of trustees of this association adopted the following resolution urging Congress to pioneer the construction of pilot atomic generating plants:

"We urge the continued public control by the Government of the United States over atomic energy and we also urge the Congress to authorize the construction of pilot atomic energy plants for electric power generation."

We should like to invite the attention of the committee to at least four specific sites for such atomic stations: The existing sites of Hanford, Wash., and Arco, Idaho, are already under the AEC jurisdiction. Two additional possibilities are Anchorage, Alaska, where there has been much interest on the part of the Chugach Electric Association, an REA borrower, serving some 8,000 consumers, and secondly the Fairbanks, Alaska, area where there has been similar interest by the Golden Valley Electric Association, also an REA borrower. The city-owned electric systems of Anchorage and Fairbanks will likewise be very much interested in cooperating.

Alaska has the highest electric rates in the Nation. Alaska also has, and for some years must have, a continuing power shortage which is hampering, and must continue to hamper, the economic development of that Territory. The construction of electric generating facilities, regardless of type, will alleviate a bad situation. Directly and indirectly Alaska's high power costs are paid for mostly by the Federal Government.

Likewise in both the Anchorage and Fairbanks areas the Department of the Army and the Department of the Air Force have vast installations generally constructed by the Corps of Engineers and consisting of steam plants used both for heating buildings and for power generation. Thus in each of these two areas the Congress would find an excellent market for electric power at much higher rates than anywhere in the Nation.

It seems to us that such high cost power areas as Alaska provide the earlier opportunity for achieving feasibility for Federal atomic power plants.

In closing may I assure you that the Northwest Public Power Association endorses the principles of the Gore bill and urges the Congress to authorize six Federal atomic power stations, even if none are built in the Northwest.

Thank you.

Senator CLINTON ANDERSON,
United States Senate,
Committee on Atomic Energy, Washington, D. C.:

Regret inability to testify on Gore bill. Believe strongly Government should not go beyond recommendations McKinney report. To propose governmental construction program clearly guarantees continued domination of field by Commission laboratories and contractors through manpower control, and delays further ultimate entrance of risk capital. Foreign market will not be captured by Gore program and my viewpoint after brief, casual discussions in several countries is that orderly and determined progress by competitive industry will be most effective in both near and long-term future. Government effort should concentrate on helping industrial and educational institutions improve manpower situation.

Regards,

T. KEITH GLENNAN.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
United States Senate, Washington, D. C.:

Appreciate invitation to participate in hearings beginning May 23, regarding civilian reactor program but will be abroad and unable to attend. The following comments summarize our position relative to status of reactor program. All of our projects are part of the AEC power development program and we assume status of same will be covered by Commission reports and representatives in regard to acceleration of power program. As nuclear power is still in an experimental and developmental state it is presently a very expensive program, requiring substantial Government assistance as well as industrial participation. Therefore, if we are to move rapidly in this field, means must be provided for intensive Government support of major experimental and developmental programs in addition to enthusiastic industrial participation and assistance. We trust the above will be of assistance in connection with the Poser development hearings.

N. C. STARR,
North American Aviation, Inc., Atomics International Division.

STATEMENT BY JOSEPH V. SANTRY, CHAIRMAN OF THE BOARD AND CHIEF EXECUTIVE OFFICER OF COMBUSTION ENGINEERING, INC.

Combustion Engineering, Inc., has been engaged in nuclear work since 1946 and is currently one of the major suppliers of nuclear component equipment. In addition, the company is a prime contractor to the Atomic Energy Commission in the Naval Reactor Development Program. A multimillion dollar expansion of nuclear component manufacturing facilities has been substantially completed at the company's Chattanooga, Tenn., works, and progress is being made on the construction of a nuclear engineering and development center in New England.

The Honorable Clinton P. Anderson's telegram, dated May 10, 1956, requested specific information on the status of private reactor projects, as well as recommendations regarding means for accelerating the civilian reactor program, assuming that we consider that such acceleration is required.

It is our feeling at Combustion Engineering, Inc., that once a conceptual design is arrived at and after certain basic experimentation is done to indicate that the concept shows promise, the next step should be a pilot plant. We regard the pilot plant as an essential step to be taken if time-consuming and costly alterations are to be avoided in larger commercial reactors. As we review the status of the various private reactor projects to date, we feel that, in general, this method of progress is being followed. The deviations from what we consider the proper approach are in the direction of a more vigorous prosecution of the development and design of large nuclear powerplants without awaiting the completion of the building and operation of true pilot plants.

The pressurized water type of reactors presently being designed follow a logical course in the sequence of development from initial concept to commercial size plants. The work done by the Atomic Energy Commission and its agents for the submarine *Nautilus* and its prototype has, to a large extent, set the pattern for pressurized water reactor designs. The PWR project being built at Shippingport, Pa., is based on the work done for the *Nautilus*, but in addition, the pressurized water reactor design is taking significant steps forward in adapting

a reactor type originally devised for naval purposes to civilian power generation usage. It should be recognized that the substantial sums being spent on the development of the pressurized water reactor represent investment required to adapt a reactor type to a somewhat different function. Notwithstanding the fact that the PWR project is not due for completion until 1957, private industry has proposed and is proceeding with the design of three additional pressurized water reactors, which, if a more conservative approach were used, would await operation of the Shippingport, Pa., reactor.

The three pressurized water reactors now in the design stages are:

1. Consolidated Edison Co.'s Thorium Converter Pressurized Water Reactor

This reactor is capable of generating approximately 140,000 kilowatts of electrical power, which when added to roughly 110,000 kilowatts of conventional superheating capacity results in a total electrical generating capacity of 250,000 kilowatts. This reactor is completely privately financed.

2. The Yankee Atomic Electric Co.'s reactor

This reactor is being designed for an electrical capacity of approximately 134,000 kilowatts. This reactor is part of the Atomic Energy Commission's power demonstration reactor program. It is understood that the Government will be called upon to provide some measure of financial assistance in the design and construction of this reactor.

3. Belgian Thermal Reactor

This reactor is being designed and built in this country for a Belgian syndicate. It is our understanding that no subsidy is to be received from the United States Government for this reactor.

It is generally conceded that the pressurized water reactor type is the "most developed" type to date, this being due principally to the enormous effort over the years on the part of the Atomic Energy Commission through the Naval Reactors Branch.

Based on the boiling water reactor experiments conducted by the Argonne National Laboratory, the Commonwealth Edison Co.'s nuclear power group has preceeded with design and development work in connection with a 180,000 kilowatt electrical boiling water type of reactor. This reactor is completely privately financed and represents a major step forward without the benefit of a true prototype. Actually, a prototype more suitable than the early Argonne boiling water experiments would be the experimental boiling water reactor being designed by Argonne National Laboratory and expected to commence operation some time this year. We consider the forward step taken by the companies associated with this 180,000 kilowatt reactor very significant in view of the lack of true prototype experience. If it were not for the determined interest of the various companies involved to develop nuclear power for commercial purposes, it is doubtful that such a forward step would have been taken. It should be noted that a recent decision on the part of this group calls for the building of a true prototype prior to actual operation of the 180,000 kilowatt plant. It is our understanding that this prototype is scheduled for operation in 1957.

Based on the experimental breeder reactor No. 1, which was designed by the Argonne National Laboratory and operated in 1951, the Detroit-Edison-APDA group has proceeded with a design for a fast breeder reactor of 100,000 electrical kilowatt capacity. The Power Reactor Development Co. has been organized which will own, build, and operate this fast breeder reactor. In view of the enormous amount of development work required for this highly advanced reactor type, assistance by the United States Government has been requested under the power demonstration reactor program of the Atomic Energy Commission. The Detroit Edison fast breeder reactor, as it is commonly known, is perhaps the most advanced type being designed today and again represents a bold step taken by American industry; a more conservative approach would have awaited operation of experimental breeder reactor No. 2, the breeding reactor being designed by Argonne National Laboratory and scheduled for operation in 1959.

Based on the liquid metal development work conducted by the Atomic Energy Commission in connection with its military projects, the Consumers Public Power District of Nebraska is proceeding with the design of a liquid-sodium-cooled, graphite moderated reactor with an expected electrical capacity of 75,000 kilowatts. This reactor is being built under the Atomic Energy Commission's power

demonstration reactor program and governmental financial assistance has been requested. This reactor project does not have the benefit of a true prototype. The prototype in this case would be the SRE, which is scheduled for operation in 1957.

All of the preceding reactors have received Atomic Energy Commission approval. There are two other types which are in the early and tentative study stages.

The first one is based on the homogeneous reactor experiments conducted at Oak Ridge National Laboratory and contemplates the building of a 150,000 electrical kilowatts aqueous homogeneous reactor by 1962. This work is being conducted at this point entirely with private funds and is for the potential use of the Pennsylvania Power & Light Co.

The second is based on liquid metal technology and is a more advanced type of reactor being studied by the Florida nuclear power group.

In connection with the Second Round Power Demonstration Reactor Program of the Atomic Energy Commission, two proposals have recently been accepted by the AEC, subject to further negotiations. One represents a boiling water reactor project to be built by the Rural Cooperative Power Association of Elk River, Minn., and the other represents an aqueous homogeneous reactor for Wolverine Electric Cooperative of Big Rapids, Mich. Both of these reactors are in the early design stages and represent the work of privately owned manufacturing firms working under contract with publicly owned utility bodies.

In practically all cases the power projects being designed are "short-circuiting" the building of true prototypes. It is our feeling at Combustion Engineering, Inc., that this is an excellent example of the vigor with which American manufacturing companies and public utilities are driving ahead in the nuclear program. It must be recognized that moving ahead rapidly without true prototype experience can lead to problems, the resolution of which might be extremely difficult and costly. In view of this, we feel that duplicating a reactor type this is not "proven" might lead to a serious setback in the Nation's nuclear program if major difficulties are encountered. Insofar as duplicating a proven type is concerned, we feel that the reactors being designed and built under the Atomic Energy Commission Naval Reactor Branch are providing American industry with information in the design and manufacture of nuclear component equipment which will be of value in ultimately decreasing the cost of nuclear power generation by utility companies. We feel that the effort in connection with the naval reactors branch program should not be minimized when comparing the extent of knowledge and general "know-how" of American industry with foreign countries. Furthermore, it is generally recognized that generation of electricity at this time by atomic power in the United States is not economical. We therefore feel that the naval reactors program, where economic considerations are not commanding, is providing American industry with considerable know-how without "saddling" either the public utilities or the public with unnecessary high costs.

We feel that if reactor types other than the PWR systems are built in quantity at this time, not only would we have a serious drain on extremely limited scientific and technical manpower and materials, but would bring about a possible setback in the overall Nation's nuclear effort if major problems do arise. Based on the experience of combustion engineering in the nuclear field, it appears that the problems facing the designers and builders of reactors are major ones involving materials and manufacturing techniques as well as economics. It is our opinion that by attempting to resolve these problems for each of the reactor types being designed today, we will be making substantial progress toward economic civilian atomic power.

Regarding recommended steps which might expedite the civilian atomic program, we at Combustion suggest the following:

1. Intensive development should proceed on the advanced promising types of reactors which point to the possibilities of economic power generation at some time in the future.

2. Declassification to the maximum extent consistent with national securiy would be of considerable assistance in promulgating vital information.

3. Periodic meetings open to qualified manufacturers and prospective reactor operating companies should be conducted covering the status of the different reactor types. These meetings should highlight problems being encountered and solutions to these problems so that industry can appraise the situation and determine the desirability of constructing these different reactor ypes. Meetings of the type proposed are currently being conducted on a somewhat limited basis,

but it is our opinion that these meetings should be more frequent and should encompass all reactor types which the Government is supporting.

4. We feel that bilateral agreements for cooperation on power reactors with various friendly foreign countries should be effected as expeditiously as possible and that simplified procedures be developed to permit transfer of information. Combustion Engineering, Inc., over the years has been selling conventional steam generation equipment abroad and has worked quite successfully through licensees, where the licensees would manufacture components to the company's designs. We must recognize that due to economic ground rules in many foreign countries and also due to the high cost of fuel in many areas abroad that nuclear power generation will probably be justified sooner abroad than it will in the United States. In view of this, we feel that within the near future manufacturing companies should be permitted to transfer the type of information required not only for export of complete reactors abroad but for the manufacture of reactor components through licensees.

5. A significant step forward could be taken if standardization and codification of reactor safeguard requirements could be effected. We have noted that as much as one year has been required in the past between the application for a construction permit and the granting of a license to construct a reactor. Although we realize that this would represent a major and difficult effort, we nevertheless feel that a definitive code covering reactor safety would be valuable. Engineering manpower might be relieved of unnecessary studies covering reactor safety without jeopardizing the safety of reactors.

In conclusion, Combustion Engineering, Inc., feels that the Nation's reactor program is proceeding along the right track and that the effort being expended on the design, development, and construction of the more promising advanced reactor types is of major magnitude. We feel that the naval reactor program of the Atomic Energy Commission is providing considerable know-how in design and manufacture of reactor components and that this should ultimately help decrease the cost of building reactor equipment. We consider it undesirable to build duplicates of advanced developmental reactor types in quantity in view of the possible setback to the Nation's program in the event of difficulties. It is our opinion that the progress being made in nuclear technology and design in this country is far in advance of the strides being made in Europe. It is our opinion that due to the different economic ground rules used abroad in determining costs of power as well as due to the high cost of conventional fuels, economic nuclear power generation may come sooner abroad than it will in this country; consequently, immediate steps should be taken to facilitate the exchange of information with foreign nations so that American industry can participate in this foreign market.

Chairman ANDERSON. In addition to these statements, a separate statement by Mr. Murray, a member of the Atomic Energy Commission, will be incorporated in the record immediately following the testimony and statement by the Commission witnesses (p. 109).

Finally, we will include in the record a statement which has been requested of the Metals & Controls Co., and a number of other industrial concerns which are contractors or potential contractors in the atomic energy program.

We are very happy to have Mr. McMahon present his statement on behalf of his organization. Will you identify yourself and the groups that you represent?

STATEMENT OF ANDREW J. McMAHON, CHAIRMAN OF THE POWER AND ATOMIC ENERGY COMMITTEE OF THE UTILITY WORKERS UNION OF AMERICA, AFL–CIO

Mr. McMAHON. I will, sir. My name is Andrew J. McMahon, president of Local 1–2, Utility Workers Union of America, affiliated with the AFL–CIO, with a local membership of 24,000. Our office is at 1453 West 51st Street, New York City. I am also chairman of the

power and atomic energy committee of the Utility Workers Union of America, AFL–CIO, our national organization. We have offices in Washington, D. C.

Our union holds genuine collective bargaining contracts with private utility companies throughout the United States covering approximately 90,000 members. A number of these companies are presently building, or are in the process of completing plans to build, nuclear reactor plants for the generation of electric energy.

Since 1948, our union has on every occasion opposed Government in the field of generation and distribution of electric energy. We have objected to all Government, whether on the Federal, State, or local level, building and operating hydroelectric plants or steam plants.

At our seventh constitutional convention in Boston, Mass., on October 20–23, 1954, we adopted a resolution endorsing the action of the 83d Congress in enacting legislation granting limited use of fissionable materials to private industry under rigid and exacting control as is indicated in the following language:

Be it further resolved, That the Utility Workers Union of America, CIO, believes that monoply should be avoided in civilian atomic energy development for nonmilitary purposes by turning that development over to many hundreds of industrial competitors by license and control which would provide the usual patent safeguards necessary to spur private initiative and bring inestimable low-cost benefits to all of the people of the world, * * *.

Chairman ANDERSON. Could I ask you there if the organization has similar objection to a contractor operating a plant for the Government?

Mr. MCMAHON. No, sir; we do not.

Chairman ANDERSON. Thank you.

Mr. MCMAHON. The officers' report to the Eighth Constitutional Convention of the Utility Workers Union of America, AFL–CIO, at Atlantic City on April 5–7, 1956, under the heading "Atomic Energy," contains the following:

The application of atomic energy to peaceful purposes continues to grow daily. The atomic industry is not only one of the largest users of electric power today but it also promises to be the potential source of fuel for the increased electric power needs of the country in the future. Many of the companies with whom we have contracts contemplate its future use. A number have already made application and are in the process of planning to build atom-powered plants. Because of the great possibilities of this new form of power in the utility industry and because of its control by the Government, a new factor has been injected into the problem of public or Government controls in the power industry. Your officers and the committee on public power have been in close touch with all the legislation governing the use of atomic power.

As indicated from the above, the subject matter of the Gore bill, S. 2725, if of vital interest to the wages, hours, and working conditions of all of our members. It is also of interest to the millions of unionized wage earners in the United States who presently have the highest living standards in the history of mankind. These gains, including wages, welfare programs, pensions, unemployment insurance, and social security, were obtained by the process of collective bargaining over a period of almost 50 years.

As unions have gained in strength and numbers, they have been able to get for their members, directly and indirectly, an ever increasing amount of profits of business enterprise. No amount of collective bargaining could ever have gotten anything comparable from a Government or governmental agency.

Chairman ANDERSON. Could I stop you there to point out that we have been discussing more the approach of the Shippingport reactor, where the Government has put up most of the money for the nuclear parts of the plant, and the private company is putting up the money for the development of the steam into electric energy, but the entire operation is under the control of the Duquesne Power & Light. You have no objection to that type of an operation?

Mr. MCMAHON. No.

Chairman ANDERSON. I just wanted to get the record clear, so that we would not have the statement made that your organization opposed that type of an operation.

Mr. MCMAHON. I think that in the conclusion I can take care of that, Senator.

First of all, you cannot bargain collectively with Government and, secondly, governments do not have profits to divide with anyone. Governments merely have taxes which they take from everyone, and whenever governments go into business, there are just that many more taxpaying companies taken off the tax roll.

The first convention of the combined American Federation of Labor and the Congress of Industrial Organizations held in December of 1955 adopted a resolution on atomic energy and, in essence, recognized the need for genuine trade unions bargaining with private-enterprise companies in the atomic field.

Quotation from the preamble to the resolution adopted at that convention is as follows:

> The widening of private activity in this field must take place on a truly competitive basis to bring to the American people the benefits to which their investment in atomic energy entitles them. The Government must therefore encourage participation by as wide a variety of responsible private enterprises as practicable and must assure such enterprises an equal opportunity through appropriate provisions for access to necessary atomic information and resources; now, therefore, be it * * *

The resolution itself, under subdivision (8), contains the following language:

> (8) The growth of atomic energy operations requires that particular attention be directed to the developments of:
>
> (*a*) A sound labor-management relations program, with maximum emphasis on free collective bargaining as an integral part of broadened private enterprise.
>
> (*b*) Effective health and safety standards to meet the special hazards presented in work with radioactive materials.
>
> (*c*) Provisions for fair compensation for workmen suffering radiation injury.
>
> (*d*) A voluntary manpower program to assure a necessary supply of competent skilled labor to meet our atomic needs.

The Utility Workers Union of America, AFL–CIO, heartily endorses the position taken by the first AFL–CIO convention on atomic energy as stated above and we think that the present Gore bill, S. 2725, is woefully lacking in the necessary protections to wage earners in the field of generation and distribution of electric energy.

Specifically, the bill contains no endorsement of the principle of free collective bargaining so necessary in the growth of labor management relations. The bill contains no reference to prevailing rates of pay and other benefits as spelled out in the Bacon-Davis Act and the Walsh-Healy Act. The bill contains no reference to the health and safety and welfare provisions so carefully spelled out in the AFL–CIO resolution above quoted.

Frankly, the Gore bill, S. 2725, is but another effort to put the Government into the business of generating and distributing electric energy and we are unalterably opposed to it.

In conclusion, we urge upon the Congress to make available to the private utility companies of our Nation every conceivable assistance in the development of atomic energy under rigid regulation for the generation of low-cost electric light and power to the end that the peoples of our Nation shall lead the world in the benefits of this modern development for a better and easier way of life.

Senator, so that there be no misunderstanding, there possibly has been or will be another union who may testify on that question, and who may claim jurisdiction in the field of the generation of electric light and power. With your permission, I would like to read into the record a telegram which I received from the national president of our union, which outlines our jurisdiction, because we will have no chance for rebuttal once they make that claim.

Chairman ANDERSON. There are only 2 more people to testify and 1 is Mr. Patton, whose statement will be read for him, and William A. Mills, executive vice president of the Empire State Chamber of Commerce.

I am quite sure that neither one of those are members of your organization. I will be very happy to have you put the telegram into the record.

Mr. MCMAHON. It just outlines our jurisdiction and there is nothing controversial except with the labor groups themselves.

Chairman ANDERSON. We will have that in record. When it comes to a contest within the labor groups themselves, I want to say Walter Ruether's statement in behalf of the United Automobile Workers was strongly in favor of the Gore bill.

Mr. MCMAHON. Unfortunately, we disagree very definitely with Walter Ruether. And he may speak for the automobile workers, but he cannot speak for the utility workers.

Chairman ANDERSON. I understand. I just wanted to remind you that we get these divisions, and there is not much that can be done about it. Thank you very much.

(The telegram referred to is as follows:)

MAY 20, 1956.

Mr. ANDREW J. MCMAHON,
Chairman, UWUA's Committee on Power,
143 West 51st Street, New York 19, N. Y.:

In answer to your question on jurisdiction please be advised as follows: Our union was granted jurisdiction by the CIO for all employees engaged in the production and distribution of electric power. The fuel used, be it coal, oil, gas or an atomic power pack, does not change or alter our jurisdiction.

Under the terms of the AFL–CIO merger we maintain the same jurisdiction we were granted by the CIO and will protest claims by the oil workers or any other union of jurisdiction in the electric power industry except that the IBEW had such jurisdiction in the AFL prior to the merger.

JOSEPH A. FISHER, *National President.*

Chairman ANDERSON. I think the program that may be contemplated probably does not run contrary to what you are talking about. When you give a contract to an operator to build the plant, there is no way of putting the Government into the utility business and you naturally make a contract with some private utility to take the power or the steam or whatever it may be and turn it into electric current.

It probably will be the operator of the plant and therefore, generally speaking, you are in exactly the same position as if a private utility was doing it all of the way through.

Mr. McMahon. As long as we have our collective bargaining rights, and the right to bargain with the employer, then we appreciate it.

Thank you, very much.

Chairman Anderson. All right, we will have Mr. Patton's statement, please.

Mr. McDonald. My name is Angus McDonald, assistant legislative secretary of the National Farmers Union. I will read this statement on behalf of James G. Patton, our national president.

STATEMENT OF JAMES G. PATTON, PRESIDENT OF THE NATIONAL FARMERS UNION (AS READ BY ANGUS McDONALD, ASSISTANT LEGISLATIVE SECRETARY OF THE NATIONAL FARMERS UNION)

As president of the National Farmers Union, I am here to present the views of my organization on S. 2725 which would authorize and direct the Atomic Energy Commission to construct six nuclear power plants for the production of electricity. This legislation, if properly amended, is consistent with the historic position of the National Farmers Union as determined by resolutions unanimously adopted at our national convention in March 1956 at Denver, Colo. We appear in support of the legislation believing enactment to be in the interest of agriculture and industry. We believe enactment of the legislation would also enable our Government to carry on a constructive foreign policy which is in part dependent upon our position of world leadership in the field of atomic power.

The resolutions adopted at our convention attempted to carry forth a policy in regard to the administration and exploitation of natural resources which was first coherently stated in the administration of President Theodore Roosevelt. The view of President Roosevelt, as well as successive Republican and Democratic administrations, was that the public domain which included the navigable waters of the Nation should be distributed or administered to benefit the maximum number of citizens. Keyed to the principle of maximum use of resources was Roosevelt's dictum that wide use could only be attained by comprehensive development of a river system. This has come to be known as multiple-purpose development, which includes flood control, navigation, generation of electric power, soil conservation, conservation of wildlife, conservation of water for industrial and residential users and for recreation.

We consider atomic energy to be a part of the public domain. The fact that it is Federal property leads us to believe that the same standards should be applied to its use by private, public and farm cooperative groups. Congress has established certain standards in the development of river basin resources which first were recognized in the Reclamation Act of 1906. Subsequently, the principle was elaborated on in other acts, including the 1920 Power Act and legislation which set up the Tennessee Valley Authority, the Bonneville Power Administration, the Southwestern Power Administration, and the Southeastern Power Administrtaion and other legislation which authorizes other programs and projects. Multiplepurpose develop-

ment and the distribution of low-cost power consistent with good business principles is not a novelty in congressional statutes. Although, the right of the people to have first call on power developed at Federal projects has been under incessant attacks for 50 years, the Congress has never retired from its original position that public bodies and farm coopertives should benefit as owners from the development of natural resources.

Congress and the courts have implemented and applied this broad policy. In the Flood Control Act of 1944, Congress authorized the Secretary of Interior to build transmission lines if neecssary to the fulfillment of the preference clause and in 1941 the United States Supreme Court upheld the right of the Congress to build facilities necessary to carry out comprehensive multipurpose basinwide plans. The Court said:

> But there is no constitutional reason why Congress or the courts should be blind to the engineering prospects of protecting the watersheds. There is no constitutional reason why Congress cannot, under the commerce power, treat the watersheds as a key of flood control on navigable streams and their tributaries. Nor is there a constitutional necessity for viewing each reservoir project in isolation from a comprehensive plan covering the entire basin of a particular river.

I do not need to spell out in detail the benefits which agriculture has derived from the rural electric power program. At the beginning of the program in 1935 only 10 percent of American farmers enjoyed the use of central electric power stations. The administration of the Rural Electrification Act and the support of the rural electrification program by both Republicans and Democrats should make every American proud of his country and his Government. Today 93 percent of all American farms are electrified.

I do not mean to imply that American agriculture is 93 percent electrified. American farmers, as American industry, stand on a thresold of a new electric era. The job of rural electrification is far from complete. Vertical expansion of farm electrification, if vast amounts of low-cost power are made available, is now in order. We are hopeful that American farmers will have the opportunity of putting to work for them many additional millions of kilowatts of electric energy. Here are some examples of the way in which increased electric output will be used.

Dairy barns will not only be equipped with electric milkers and electric cooling systems, feed and barn cleaning will be done by electricity, eggs will be graded, air conditioned, and boxed by electricity. More efficient brooding and farrowing of hogs will be brought about. Infrared lights which will insure one additional pig per litter will be installed. Air conditioning will make possible more rapid farrowing and reduce feed per pound of weight. Electricity will chop and handle silage, grind and cut feed, and dry feed and grain.

Supplemental irrigation to relieve eastern as well as western farmers from the uncertainty of climate will make possible maximum crop production on farms. Farm homes will be air conditioned and equipped with deep freezes, vacuum cleaners, and all kinds of labor-saving electric appliances. We envision a transformation of farms and farm homes in the future by means of electricity.

But, in order to bring about such a transformation or even provide the minimum needs of agriculture, abundant power must be provided

at low cost. We do not believe that private industry will fulfill these needs without encouragement and example by the Government. We advocate yardstick plants in various economic regions in the United States, in order that private industry may be kept on its toes by having to meet competition. State regulation and Federal regulation are partially ineffective because without yardstick plants, the private electric power monopoly has little incentive to lower its rates. Federally constructed plants such as are called for in this bill have been more effective than the most efficient State or Federal regulation.

Looking at the Nation, as a whole, it is apparent from various industrial forecasts that the production of electric power by one means or another must be greatly accelerated in the near future. According to a forecast published in the magazine Electrical World, September 15, 1955, the Nation will need to increase its electrical capacity 500 percent by 1980. In 1954 installed capacity was 103.7 million kilowatts. The prediction of this trade periodical is predicated on an average annual increase of 7.3 percent. This appears to be rather conservativ. Agriculture has been doubling its electric power consumption about every 4 years. But using the 7.3 percent figure installation capacity which would increase to 166.9 million in 1960, to 320 million in 1970, to 600.7 million in 1980. It is estimated that about 140 million kilowatts of this power should be produced by atomic energy.

The Nation should not continue to rely exclusively on hydro and fossile sources of energy. They are exhausible. Experts differ on the amount of reserve available, but regardless of the length of time in which these reserves will be exhausted, it would seem sensible to set about the task of producing low cost atomic electric power. Let us look for a moment at the amount of nuclear electric power which will be produced during the next few years. At the present time, only one large-scale reactor is under construction; this is the so-called Shippingport plant which wil produce from 60 to 100 thousand kilowatts of power. Two others are under contract: The Commonwealth Edison plant and the Consolidated plant which will produce, respectively, 180,000 and 160,000 kilowatts.

There are several other proposals but negotiations have not been consummated. These include Pennsylvania Power & Light, Yankee Atomic Energy Co., Consumers Public Power Co., and Atomic Power Development Associates. These 4 groups will complete their plants by 1959 or 1960, producing 400,000 kilowatts of power. In addition, Atomic Energy Commission research and experimental plants, of which there are 6, will produce 107,500 kilowatts. According to the McKinney report, page 36, volume I, these amounts of power built by private industry, private combine, or by the Commission alone, do not amount to any significant total of the Nation's generating capacity. The total amounts will be only a fraction of 1 percent of the total generating capacity in 1960.

We endorse the spirit of the recommendations of Atomic Energy Commissioner Murray. We feel that his program, of producing 2 million kilowatts at home and abroad by 1960 by means of atomic energy power reactors in view of the vast needs, and in view of the vast programs which are being carried out by the British and by the Soviets, is a very modest one.

We believe that the present plans of only a 4-percent increase in the civilian budget of the AEC power reactor program is entirely inadequate. By contrast the Commission plans to increase the military budget by 65 percent. This administration has rightly stressed, "Atoms for Peace," in its public pronouncements, but we believe that mere talk will not accomplish the task either at home or abroad.

Numerous articles have appeared in the press, describing and outlining atomic energy programs in other countries. The British as far as actual production is concerned are already ahead of us. In October of this year, one of their plants will be producing 60,000 kilowatts of nuclear power. The Russians, according to the New York Times, January 24, of this year, are planning to complete 2 million to 2.5 million kilowatts of atomic power capacity by 1960. Other countries also are making plans to bring nuclear powerplants into production.

One of the roadblocks to nuclear power production is cost. Those who contend the Government should not inaugurate a large-scale program and that industry cannot, use this plant as an example, cite the Shippingport plant as proof of their argument. However, various estimates indicate that competitive nuclear power can be produced in high cost power areas. For example at the May 24, 1954, Atomic Industrial Forum Panel in Washington, D. C., Francis K. McCune, general manager of the General Electric's atomics products division, estimated that by private financing atomic power might be produced at 6.7 to 6.8 mills per kilowatt hour, if large enough plants were constructed. It is estimated that under Federal financing nuclear power might be produced at between 4 and 5 mills per kilowatt hour.

I call attention to a study published in the appendix volume of the McKinney report: "A Forecast of the Growth of Nuclear Fueled Electricity Generative Capacity," prepared by B. R. Prentice, General Electric; John Landis, Babcock & Wilcox; Roger Coe, New England Electric Systems; W. Dee Shepherd and W. B. Stewart, Westinghouse; W. Kenneth Davis, Director of AEC Division of Reactor Development; and James A. Lane, Director, Experimental Engineering Division, Oak Ridge National Laboratory. I further call attention to estimates of these experts in the following table:

Total costs—I. "Lifetime" basis

[Mills per kilowatt-hour]

	1960	1965	1970	1975	1980
Steam plants, private:					
Fixed charges	3.5	3.5	3.5	3.5	3.5
Fuel cost	1.5–3.1	1.6–3.1	1.6–3.0	1.6–2.9	1.7–2.9
Operation and maintenance	.9	.9	.8	.7	.6
Total	5.9–7.5	6.0–7.5	5.9–7.3	5.8–7.1	5.8–7.0
Nuclear plants, private:					
Fixed charges	4.3–5.2	4.2–4.9	3.8–4.4	3.4–3.9	3.1–3.6
Fuel cost	3.0–3.8	1.6–3.0	1.3–2.2	1.1–1.7	1.0–1.5
Operation and maintenance	1.1	1.0	1.0	.9	.8
Total	8.4–10.1	6.8–8.9	6.1–7.6	5.4–6.5	4.9–5.9
Nuclear plants, public:					
Fixed charges	3.1–3.8	3.0–3.6	2.8–3.2	2.4–2.8	2.3–2.6
Fuel cost	3.0–3.8	1.6–3.0	1.3–2.2	1.1–1.7	1.0–1.5
Operation and maintenance	1.1	1.0	1.0	.9	.8
Total	7.2–8.7	5.6–7.6	5.1–6.4	4.4–5.4	4.1–4.9

It is significant that by 1960 these experts estimate that public nuclear plants will produce power at a cost of 7.2 to 8.7 mills per kilowatt which is only a little over 1 mill more than the cost of private power produced in conventional steam plants. By 1965 it is estimated that the cost of nuclear power would be slightly under the cost of conventional steam power plants. In view of the fact that the cost of wholesale power in a number of high cost power areas is greatly above these figures, we feel that the committee should seriously consider the possibility of Federal nuclear power programs.

We are particularly interested in a proposal made by the Rural Cooperative Power Association at Elk River, Minn. This plant is to be built by AMF Atomics, Inc., a subsidiary of American Machine & Foundry Co. AMF estimates that it can build a 20,000 kilowatt reactor which will produce power at a cost of around 9.5 mills. An 80 percent load factor is assumed. AMF Atomics Co. is no newcomer to the atomic energy field. It has been engaged in atomic energy development since the inception of the Manhattan Project. Its own program includes development of reactor equipment, reactor systems, and research reactors. In addition, AMF is undertaking contract work in nuclear equipment and the reactor system field for the Atomic Energy Commission. AMF also took part in the AEC industrial participating program.

We are interested in a comparison made by one of the experts in the field of hydro and nuclear power. Robert A. Charpie of the Oak Ridge National Laboratory, in an article published in volume 2, page 42, of the McKinney report states:

> The main difference between thermal stations and nuclear reactor stations is the difference in fuel costs. Nuclear reactor stations are more like hydroelectric stations, in the long run, in that they will eventually produce zero-cost fuel. It is clear that if the reactor is a breeder which breeds by a sufficiently large margin, the value of the additional fuel produced will offset the chemical recycling costs. Thus, the net fuel cost is zero.

We endorse this bill provided it is amended to incorporate the so-called Johnson amendment which was approved by the Senate during debate on the Atomic Energy Act of 1954. This amendment would have permitted the AEC and other Federal agencies to undertake a Federal atomic power program and not be restricted to atomic power generation which is incidental to research and development. The Johnson amendment also contained an effective preference in the marketing of any Federal atomic power.

We further suggest an amendment which would authorize the Commission or appropriate agency to construct transmission lines where needed. We call attention to the fact that cooperatives have been denied power because the private utilities generally will not cooperate in wheeling power to them.

The preference clause in many instances is meaningless because there is no transmission line to bring power from the bus bar to the load center and because cooperative and public groups, more often than not, cannot obtain funds to build such lines. Finally, we suggest that the AEC be required to submit its plant proposals to a system of competitive bidding.

The most important question before this committee is whether or not our country is going full-speed ahead with an atomic energy program. There are signs that private industry will not go ahead with

nuclear power programs unless the Congress exempts the companies from regulation and subsidizes them in regard to taxes and insurance. Walker L. Cisler, president of Power Reactor Development Co., and Atomic Power Development Association, Inc., told this committee that his company would not build any nuclear plants unless it was exempt from the Public Utility Holding Company Act and unless contributions of the member companies could qualify as deductible for Federal income tax purposes.

Cisler further stated that the Government of the United States should share a part of the burden in regard to the insurance. As soon as these three problems are solved, Cisler stated, "I am confident that swift fulfillment of our purposes will follow." (Hearing before Joint Committee on Atomic Energy, 84th Cong., 2d Sess., pt. I, p. 252.)

Philip Sporn, president of American Gas & Electric Corp. and of Nuclear Power Group, Inc., admitted under cross-examination before this committee that his company would charge off research costs to operating expenses and that indirectly the Government would contribute 52 percent of this amount. (Hearings before Joint Committee on Atomic Energy, 84th Cong., 2d Sess., pt. 2, p. 522, February–March 1956).

Only two companies—Commonwealth Edison and Consolidated Edison—have stated that they will carry out their proposals without any subsidy or assistance from the Government. We do not call attention to these strings which industry attaches to its proposals because we are opposed in all instances to assistance to private industry by the Government in building nuclear plants, but to indicate that one roadblock after another seems to be thrown in the way of private nuclear power development by industry.

Other serious obstacles to the nuclear power program are the lack of scientists and the tendency of the Atomic Energy Commission to discourage civilian interest by classifying atomic power information. We want to emphasize that we are not suggesting the declassification of any information which would jeopardize our security. We feel strongly that if there is any doubt as to the classification of a document, it must be resolved in favor of national defense.

However, we wonder if the Atomic Energy Commission couldn't further declassify certain categories of information and also make available articles and materials of general interest so that students, both in and out of universities, might be encouraged to enter the field of atomic energy. While it is possible for individuals to obtain certain types of clearances which give them access to certain information, we believe that the restrictions should be removed so that everyone who desires may read and learn about the civilian atomic energy problems.

Another obstacle in the way of enlarged and accelerated atomic-energy program is the lack of scientists. According to J. F. Kaufmann, Chief, Technical Assistance Section, Civilian Power Reactors Branch, Division of Reactor Development, we will need somewhere between fifty and sixty-five thousand scientists and engineers in the atomic-energy field by 1975. An industry survey indicates that we have about five or six thousand scientists in the program now, and we are only producing about 500 new ones each year.

We recommend that the committee seriously entertain the idea of setting up a system of scholarships, so that promising students may

enter the atomic-energy field. It appears that one of the difficulties is lack of money available to the universities, both as to providing expensive equipment and facilities and employing additional faculty personnel. Universities should be subsidized and atomic-energy students should be provided with necessary funds. We are mindful of the steps that the Atomic Energy Commission has taken in regard to use of facilities by the universities and new policies designed to alleviate the shortage of scientists and engineers, but we believe that much remains to be done.

Finally, we emphasize the fact that our country is engaged in a worldwide struggle for the hearts and minds of men. The economics of nuclear power generation, while important, is secondary. We are faced by the greatest threat to human liberties that the world has ever known. We cannot fail to win this struggle.

The key to our future and to the future of the free world lies in the energy resources. We must produce the vast amounts of low-cost energy necessary to an expanding economy and a constantly rising standard of living. Our leadership and our survival depend on energy production. Our leadership must be daring, it must be dynamic, and it must meet the Soviet challenge. America must forge ahead in this new age of miracles.

Chairman ANDERSON. I realize this is Mr. Patton's statement, but he says he is in favor of this bill if amended, and he then mentions the provisions of the Johnson amendment that was in the bill as it at one time was voted by the Senate in 1954. That included the preference clause. We have had some discussion of that, and the statement has been made that perhaps we could afford to go ahead and fight the preference clause question out later because in the New England States, for example, it does not mean too much to have a preference clause. When the power was available at West Milton, from the General Electric plant, there were no people there available to take it under the preference clause. It just had to be sold to anybody that came along, and I believe Niagara-Hudson Power Co. took it over. That is because of the character of it for a while.

The Gore bill is quiet on that point. Would you still feel that the preference clause needed to be added to it?

Mr. MCDONALD. Mr. Chairman, as I recall the Atomic Energy Act, the Commission is not authorized to give preference except in instances where the production of electric power is incidental to the research and development projects. That part of the act, we feel, is weak in that the Atomic Energy Commission is precluded from giving preference. I assume any other agency which marketed this power would necessarily have to give preference.

The recommendation here is a little bit larger. Under the act as we understand it, the Atomic Energy Commission could, if it wished, build these plants except that it would not be required to give preference, and it could not directly go into the power business. We would like to, if we ever get an Atomic Energy Commission that would feel that way, we would like to have the Commission have authority to go and build some yardstick plants. Perhaps not six, this number is very arbitrary and, of course, we do not know what number should be built. The scientists really should determine those questions, but the suggestion in this amendment, Mr. Chairman, is an attempt, really, to broaden the authority of the Gore bill.

Chairman ANDERSON. Thank you very much.
Mr. Mills is the next witness.

STATEMENT OF WILLIAM A. MILLS, EXECUTIVE VICE PRESIDENT OF THE EMPIRE STATE CHAMBER OF COMMERCE, INC.

Mr. MILLS. My name is William A. Mills. I reside at 1102 Western Avenue, Albany, N. Y. I am here today in my capacity as executive vice president of the Empire State Chamber of Commerce. I am making an appearance on behalf of the following organizations: Arkansas Economic Council-State Chamber of Commerce; Colorado State Chamber of Commerce; Georgia State Chamber of Commerce; Idaho State Chamber of Commerce; Indiana State Chamber of Commerce; Kansas State Chamber of Commerce; Maine State Chamber of Commerce; Missouri State Chamber of Commerce; Montana Chamber of Commerce; Ohio Chamber of Commerce; East Texas Chamber of Commerce; South Texas Chamber of Commerce; West Virginia Chamber of Commerce; New Jersey State Chamber of Commerce; The Salt Lake City, Utah Chamber of Commerce.

I have also supplementary telegrams, and this is my authorization to speak for these organizations.

Chairman ANDERSON. They will be added at the conclusion of your statement.

Mr. MILLS. The Empire State Chamber of Commerce is a federation of local chambers of commerce and statewide trade organizations with an underlying membership of more than 80,000 business firms, serving some 15 million people. Our member organizations represent a typical cross-section of business and community life in New York. They vary in size from the great New York Chamber of Commerce which is the oldest continuing business organization in the world to organizations in such typical rural trading centers as Schoharie, Schenevus and even North Creek, which has a population of only 703.

Chairman ANDERSON. I know Schoharie did a very good community job, because I was there at one time when I was in the Department of Agriculture, and I made a farm speech, and we not only made use of the churches to carry the speech by wire over these churches and loud speakers there, but put on a wonderful community banquet.

Mr. MILLS. That is not only a thriving rural trading center but one of the best-known eating places in the State of New York.

I come today not as a representative of big business nor as a representative of small business, but as a representative of the business community in New York as typified by the membership of our affiliated organizations. By this, I mean the kind of free and competitive enterprise which has been and continues to be the source of this Nation's strength and greatness through the years. The kind of competitive enterprise which has produced a social order that still makes it possible for America to be the envy—as well as the hope—of the rest of the world.

Speaking then on behalf of that section of our economy which I represent, I must record myself and those for whom I speak, as being completely opposed to S. 2725. This proposal would put the Atomic Energy Commission right smack in the electric power business and in direct competition with our efficiently operated electric companies.

Let me hasten to add that the American business community is not afraid of competition—including competition from government—if that competition is conducted under ground rules in which all competitors start off on the same footing.

It is no news to the members of this committee that Federal electric power producing and marketing agencies pay no Federal taxes and mighty few State or local taxes. Electric companies which do pay Federal, State, and local taxes have to include them in the cost of their product to the consumer. Under such circumstances competition when measured in terms of rate structure becomes a myth. There is no competing with subsidy.

The first point that I want to make about bill S. 2725 is that by establishing the AEC as an additional power agency and by granting to it all the special privileges and subsidies of other Federal power agencies, including that of tax avoidance, this bill proposes the authorization of an unfair and unwarranted projection of Federal Government into an area now served and served well by private enterprise.

While I am on the subject of taxes, let me point out that the people of New York State currently pay 14.95 percent of the total Federal tax burden. New York State's share of the Nation's $2 billion investment in TVA is almost $300 million. While the TVA is one of the most controversial and probably the best known Government ventures into the power business, it is not the only instance in which the Federal Government has created agencies financed with taxpayers' money to compete with its citizens in the electric business. In each instance the tax resources of New York taxpayers have been used for this purpose. And now comes this proposal which would set up not just 1 more, but 6 so-called little TVA's, the construction of which would call for the expenditure of about $2 billion, according to estimates recently made by Senator Pastore, almost $300 million of which would be collected from the taxpayers of my State. This is an unnecessary and undesirable extension of Government into a field where private initiative repeatedly has demonstrated its capacity and efficiency and where Government competition will retard rather than promote the most effective economic and social use of this new-found resource.

Chairman ANDERSON. What is the attitude of your organization toward the Niagara-Hudson Power?

Mr. MILLS. You mean the Niagara project. We have been on record as opposed and have testified before the Public Works Committee both of the Senate and the House in opposition to Government ownership and operation of that facility.

Chairman ANDERSON. Well, I think the bill that passed was not for Government ownership and operation of it, was it;

Mr. MILLS. Well, there are two bills that have been passed at various times. The Lehman bill recently passed in the Senate, which called for Government ownership and operation. The Miller bill that passed the previous session in the House called for private operation. So you have two conflicting points of view. We support the principle of the Miller-Dondero-Capehart bill, and we are opposed to the Lehman bill.

Chairman ANDERSON. What do you do with an area like the State of California where they are now before the Senate Committee on Interior and Insular Affairs seeking to get approval to have the Gov-

ernment spend several hundred million dollars on dams which the people of California cannot finance?

Mr. MILLS. Well, I think each issue has to be justified by the public interest that is involved. We are opposed to this bill because we feel that it is an extension of the Government into an area that is not necessary in the public interest.

Chairman ANDERSON. If you felt that American industry was getting behind and that Russian industry and British industry was getting ahead, would it be fair to conclude you would rather they would stay behind than the Government put any money into this?

Mr. MILLS. I think that I cover that in the statement, Senator, and if I do not, may we come back to it?

Chairman ANDERSON. Yes, indeed.

Mr. MILLS. In expressing the philosophy that electric power production is not a proper function of AEC, I find myself in good company. This was indicated by Adm. Lewis L. Strauss in his testimony before this committee.

The previous speakers referred to the growing needs of power in this country. Mr. Cordiner, the president of General Electric Co., one of the members of our organization and, incidentally, Mr. Hopkins, who testified earlier today, estimates that the power needs of this country during the next 10 years are going to equal the capacity that we produced in the past 75 years. The interesting thing is that Mr. Cordiner says that the General Electric and others in that business are prepared to meet the power needs of the country, so that so far as the power needs of the country are concerned, I do not think that is an issue.

Chairman ANDERSON. Could you cite us that statement of Mr. Cordiner's? I have talked to him, and I had the impression that, along with Frank McCune, who is the vice president in charge of atomic matters, felt that it was going to require some atomic development in order to keep up.

Mr. MILLS. Yes, but I said, sir, that the industry is preparing to meet the need.

Chairman ANDERSON. The industry is, if the Government will develop a whole new batch of reactors and turn it over to them free, yes. We are not worried about even doing that. But at the present time they have the development absolutely stymied because there is no way that the Atomic Energy Commission seems able to go ahead with these plants or desires to go ahead with these plants and in the meantime we have a little development that is going to run $250 million in the next 5 years, while Britain itself is spending more than that in the next 5 years and Russia is spending several times that in the next 5 years.

Mr. MILLS. Well, I know that Mr. McCune was to testify before this hearing. I have not had an opportunity to read his testimony. As a matter of fact, we had hoped that Mr. McCune might testify for us and it was only when we learned that he was going to testify for the General Electric Co. that it was decided that I should come down.

Chairman ANDERSON. I do not want to mislead you, and I think his testimony was against the Gore bill, but I think that he subsequently recognized that there might be some sense to developing types of reactors that prudent businessmen might not be ready to put their money into. I would say that the shareholders and stockholders of

business have a right to insist that the management not stray off after strange gods.

It would hardly be prudent for a business to put many millions of dollars into the development of reactors that might not be commercially feasible after they got through with it.

But a country might feel it was desirable to try it and if it worked private enterprise should then have the right to make it.

Mr. MILLS. I do not think that we are talking about the same thing. There is a difference between Government-industry cooperation and Government competition with industry.

Chairman ANDERSON. Well, the Government has got 12 or 13 or 14 billion dollars invested in the atomic-energy industry. Do you know any place where it is in competition with private industry?

Mr. MILLS. No, I do not, but as we read the Gore bill there you are going to set up generating facilities for the manufacture and generation and sale of electric power. At that point where the Government and particularly where the previous speaker comes in and insists upon a preference clause in it——

Chairman ANDERSON. You are trying to tie the Gore bill to what the witness has testified to. I refuse to be bound by what you might say about the Gore bill, and by the same token, you must not try to bind me by what somebody else says about the Gore bill. What does the Gore bill provide?

Mr. MILLS. As we read the Gore bill, it appears to us that the Congress would direct the Atomic Energy Commission to construct and operate six generating facilities, with nuclear energy as the source, and to make the sale of that power available in competition with electric companies in that area.

Chairman ANDERSON. Let me see if that is right.

The first section is that:

> The Atomic Energy Commission is hereby authorized and directed to construct six nuclear power facilities designed to demonstrate the practical value of utilization facilities for industrial or commercial purposes pursuant to section 31 of the Atomic Energy Act of 1954.

Do I understand that you are opposed to the demonstration of the practical value of utilization facilities for industrial or commercial purposes?

Mr. MILLS. If the intent of the Gore bill, as we interpret it to be——

Chairman ANDERSON. I just wanted to state the language of it. It is like stating the Declaration of Independence was such that behind it was the intent to set up a monarchy. I would resist that, because that was not in the Declaration of Independence. Or to say the Declaration of Independence was designed to provide a world government. I do not think it was. Let us look at the language of the Gore bill. What does the Gore bill say? I am just reading this section, and there may be some other sections. But this section directs the construction of six nuclear power facilities designed to demonstrate the practical value of utilization facilities for industrial and commercial purposes pursuant to section 31 of the Atomic Energy Act of 1954.

Are you opposed to that?

Mr. MILLS. Yes, sir; we are.

Chairman ANDERSON. Now then, it says that the—

nuclear power facility shall, insofar as feasible and practicable, be of a different design, each design being selected on the basis of a determination that the construction of a facility so designed gives promise of making a significant contribution to the advance of the science and technology of the commercial and industrial aspects of the atomic-energy program.

Are you opposed to such a significant contribution to the advance of the science and technology of it?

Mr. MILLS. No; we feel that there is a great deal to be gained, if these facilities are to be constructed, that they be of a different character.

Chairman ANDERSON. All right, now, the next provision is that:

Each facility constructed under authority of this act shall be located in a different geographical section of the United States. In selecting sites for each facility, the Commission shall consider the suitability of the proposed reactor type for the particular location and the need for additional electric-generating capacity in the region of the site under consideration.

That was designed to help out the New England States, for example. Are you opposed to that?

Mr. MILLS. Senator, we are opposed to the Government engaging in any activity that is designed to perform a service that it cannot perform for all people in the country.

Chairman ANDERSON. I am trying to find out what you object to in the bill. I read you this statement. Are you objecting to that? Do you object to it being located in different geographical locations of the United States and in selecting these sites that the Commission should consider the suitability of the proposed reactor type to the particular location and the need for additional generating capacity in the region?

Mr. MILLS. We object to it, Senator, with the feeling that the building and operation of electrical plants is not a proper function of the Atomic Energy Commission.

Chairman ANDERSON. I am just trying to find out if you object to that particular section.

Mr. MILLS. I think that I cover that in this sentence from my prepared statement:

While I do not underestimate the importance of the production of electric power to America's security, I am sure that there are other activities of the AEC which are more important to that security and which more properly deserve the attention of the Commission and its staff and which should have first call upon the tax resources of the people.

That is the essence of our statement.

Chairman ANDERSON. There is only one more section of the bill except the appropriating section. The last one says:

It is hereby declared to be the intent of the Congress that the full resources of the United States should be made available to advance the art of generation of electric energy from nuclear energy at the maximum possible rate.

Are you opposed to developing at the maximum possible rate?

Mr. MILLS. No.

Chairman ANDERSON. Then I read further:

The reactor construction program authorized by this act shall be in addition to the reactor development program being carried out by private or public groups under licenses authorized by section 103 of the Atomic Energy Act of 1954.

I think that that should be section 104, but you do not want to stop the present private program?

Mr. MILLS. No.

Chairman ANDERSON. You would not object to that?

Mr. MILLS. No. We would object to the provision that it be in addition to. In other words——

Chairman ANDERSON. This says that if you are going to do it, that it must be in addition to private programs.

Mr. MILLS. If you are going to do it.

Chairman ANDERSON. You would not object to it being in addition, if you are going to do it?

Mr. MILLS. No.

Chairman ANDERSON. What did we finally end up with in the way of objection?

Mr. MILLS. Well, I go back to my statement, sir, that we feel that the directing of the Atomic Energy Commission to directly engage in the construction and operation of these facilities is a function that can presently be performed by private industry.

Chairman ANDERSON. Did you bring in the word "operation"? Where is that word?

Mr. MILLS. It says right in here in the opening paragraph, "directed to construct six nuclear powerplants."

Chairman ANDERSON. You added the word "operation." Would you point out to me where that is in the bill?

Mr. MILLS. It may be that we are unnecessarily concerned and we are reading things into the bill that are not intended.

Chairman ANDERSON. A lot of testimony that has been directed against this bill has been directed to a bill that does not exist. I do urge you to go back home and read the delightful story about Marjory Daw. There is a story of a fellow who went up in the New England country for his summer vacation, and he wrote a whole series of letters home telling of his romance with this lovely girl, Marjory Daw, that he met rocking on the front porch. The last letter he has to admit that it has been imaginary all of the way through and there was not any resort, and there was not any front porch, and there was not any rocking chair, and there was not any Marjory Daw. I just want to say that this bill is similar to that. You read things into it that are not there. Of course, if you can bring me a statement that says, "and they are going to sell this in competition and they are not going to pay any taxes and they are going to sell it at rates that will put the private people out of business," and so forth, we might have a different proposal. That is not what is proposed.

Mr. MILLS. I read in Senator Gore's statement before this committee on the opening day:

> I am aware of the fact that our country is blessed with comparatively abundant supplies of conventional fuels. Our supplies, however, are not inexhaustible and there are regions of our great country which even now are known as high-cost power areas.

Now we may be unnecessarily aroused, but having been concerned with this problem right on our own doorstep, we are concerned when another agency of Government is empowered to go into business.

Chairman ANDERSON. Show me where it goes into business.

Mr. MILLS. I am reading Senator Gore's statement. Now, I take that as the intent of the introducer of this bill.

Chairman ANDERSON. Let me see if I understand you. You object to the fact that Mr. Gore said that there are high-cost areas in the United States. Do I understand that you deny that?

Mr. MILLS. Do I deny what?

Chairman ANDERSON. That there are high-cost areas in the United States.

Did you not see the information that was brought before this committee, that showed circles of costs of electric energy in various parts of the United States? Do you deny that that exists?

Mr. MILLS. That might be so, sir, but there are compensating factors.

Chairman ANDERSON. I grant you that.

Mr. MILLS. I might like to spend the weekend down at the beach in New Jersey, and the people in New Jersey have the great Atlantic Ocean at their disposal, and it is theirs for walking down and taking advantage of it. But if I am in Albany, N. Y., I have to assume the cost of getting to that.

Now what we object to——

Chairman ANDERSON. You cannot say the Atlantic Ocean does not exist, it is there, and the high-cost areas are there.

Mr. MILLS. I do object, sir; to taking tax dollars collected in the State of New York and using them for the development of a low-cost electric energy in competition with the taxpaying industries of the State of New York.

Chairman ANDERSON. Where is that in the bill? Are you not here objecting to something that you think may happen in the next year or the next generation?

Mr. MILLS. No, sir; I am not. I believe that if these generating facilities are constructed they will be used as so-called yardstick factors and will further complicate this whole problem of Government-private business competition that we have had for a number of years. This is not on the subject, but you asked me about the Niagara project. Let me tell you what is happening up in my State.

You know that the Congress has authorized and there is under construction the St. Lawrence seaway. As a part of that facility, we are generating in cooperation with Canada considerable electric energy. There is a preference clause in that legislation. There are a number of communities right now that have been customers of the private power companies that operate in that area. They are taking steps to construct and operate municipally owned distribution facilities. The State of New York loses not only the possibility of collecting taxes if those facilities are constructed by private and publicly financed companies, but they also stand to lose the tax resource as represented in the productive capacity in this situation.

Chairman ANDERSON. Now we are getting down to something that I can understand with you. Do I understand that this preference clause then, that was written into this law, has really disturbed you?

Mr. MILLS. Yes, sir.

Chairman ANDERSON. Now, was that preference clause not written in by the Congress of the United States, by majority vote?

Mr. MILLS. Yes, sir.

Chairman ANDERSON. Are you opposed to majority vote in the Congress of the United States?

Mr. MILLS. Well, sir; that is like asking, "Have you stopped beating your wife?"

CHAIRMAN ANDERSON. I want to come to the next question: Was it not signed by the President of the United States?

Mr. MILLS. Yes, sir.

Chairman ANDERSON. Was he not elected by a majority vote?

Mr. MILLS. Yes, sir.

Chairman ANDERSON. Do you not think that when a Congress which is legally constituted passes a bill which is then signed by the President, legally elected, that that bill must become effective in this country?

Mr. MILLS. Sir, it may be legal, and it may be in keeping with the due processes, but I think only time will tell whether it was in the public interest. I am of the opinion that time will indicate that it was not in the public interest.

Chairman ANDERSON. Well, the President must have thought differently. You argue that out with Mr. Eisenhower.

It has been my position throughout these hearings that they should not be concerned with the so-called public power or private power issue. Since we are discussing developmental prototype reactors of an uneconomic nature, and not proved commercial power-producing reactors, there is no real public power issue. We tried to keep it out of it.

I am just trying to find out about this.

Mr. MILLS. I did not come for that purpose. If I have any purpose here today, it is because we are genuinely concerned with the tremendous tax burden that we already have, and the fact that we believe that what is intended to be done by the Gore bill can be done by private business with the cooperation of the Government.

Chairman ANDERSON. But you see what you do, you send this statement out to the people that have authorized you to come in here. You say that this bill would call for the expenditure of about $2 billion according to estimates of Senator Pastore. He did not make any such estimate of the cost of the Gore bill. This is just thrown in to scare people. But I do not think it is fair criticism.

Mr. MILLS. That certainly was a public statement credited to Senator Pastore.

Chairman ANDERSON. Senator Patsore was talking about the program that Commissioner Murray had proposed for the construction of 1 million kilowatts in the United States and 1 million kilowatts abroad.

Mr. MILLS. In the development of this statement which was developed by my research staff—and we worked this out together—we took several sources of information including the Senator's statement, the chairman's statement, and whatever we could. We understood that the Senator made that statement, and it is in here in good faith. I believe that he did make it.

Chairman ANDERSON. I think my feeling on this is perhaps this: I used to be rather active in the chamber of commerce in my home community. My business is a substantial contributor to the chamber of commerce, I hope. When it got in bad condition many long years ago, I was one of the group that reorganized it and made it a very active and lively chamber of commerce. One day here in Washington I got a resolution of that chamber of commerce telling me how to vote on a very important measure. So I merely filed that away and I went back home one time, and I went to see an old friend who had been an official of the chamber of commerce. I said, "What was wrong with this bill?" And he said, "I do not know. We got a wire from the United States Chamber of Commerce to be against it." I said,

"Well, if they had asked you to be against religion, would you do that?" He said, "No," and we went down the list and I could not find a single soul that could tell me one thing wrong with the bill.

Now, I have tried to give this to you here. I am trying to find out what you find wrong with the bill. I take it section by section, and you do not find so much wrong with it. It is what you read into it and what you fear may follow. I have been hoping that the development of atomic energy in this country would not continue to be held back by a fear that the development of this new power is going to destroy the capital investments of people in utility bonds and stocks and other holdings.

I think that the greatest blow that could happen to the individuals who have securities in these companies is to have our industry get far behind the British and far behind the French and far behind the Russians and wake up some day and find ourselves in a bad position as a second-rate nation. That is a matter of opinion. I say that as an individual who has been investing some of his own money and some of his insurance company's money in the securities of the electric industries and others. I do not worry about them. I think that they are going to be fine and they are going to do better if we develop atomic energy and make it competitive than if we do as I think we are now doing, becoming so frightened that it is going to become a part of this public versus private power fight that we just stop the development of these reactors.

Mr. MILLS. I think it would be most unfortunate if that became the determining factor. I think what we want to do and what I am trying to argue for in this statement is to use the tax resources that we have in this Nation in its most effective manner, and effective from the standpoint primarily of the national defense, and secondarily, for our general economic welfare.

Historically, Senator, I think when the chips are down, American business has demonstrated that it meets its obligations and whether it is in preparing for war or preparing the products for domestic and foreign consumption, we have a pretty good record in world competition.

I think when this record is written, that we are going to have an equally impressive record in the development of atomic energy.

Chairman ANDERSON. In the hearing we had in California, on a water project the other day, in the Interior Committee, someone now thought it possible that if the Government had stayed out of the Columbia River Basin, the private industry would have gone there and built those great dams and other structures. I happen to have known a little bit about how the project got started. Any man who thought there was anybody ready to start building Grand Coulee Dam in 1934 or 1935 or 1936 is certainly not looking at the true picture. Occasionally there is a place where the Government has to step into the picture. It had to in the Central Valley project in California. It had to in the upper Colorado Basin development, and so on.

Now, in this particular deal, there are some of us who believe that the reactor program ought to be speeded up. I, for one, am a little surprised that so many business enterprises and so many business people think that has to be fundamentally bad for this country.

But you go ahead.

Mr. MILLS. Proponents of this bill have tried to scare us into believing, first, that little or nothing is being done in the development of the atom for peaceful purposes by private enterprise; and second, that other countries, notably Great Britain and Russia, will beat America in some as yet unidentified race for some as yet unidentified prize.

I do not presume to be, and members of this committee would not accept me as an expert in atomic technology. I consider myself, however, a reasonably well-informed American citizen who reads his daily newspaper and has a personal as well as professional interest in keeping abreast of these matters. My interpretation of what I read and hear leads me to believe that the fears expressed by the proponents of this legislation are not substantiated by fact.

American industry has demonstrated its willingness and its capacity to proceed with the development of nuclear energy and to utilize its own funds to do the job. Under Government license and necessary supervision, great progress has been made in just 2 years' time and will continue to be made.

In my own State, as has been pointed out earlier, Consolidated Edison Company of New York, Inc., serving the largest concentration of people and economic wealth in the world, is moving ahead on its own with a $55 million nuclear reactor at Buchanan, N. Y. Not 1 penny of taxpayers' money is involved in the project. This is an excellent example of the progress that has taken place in the 2 years since the passage of the Atomic Energy Act.

It is hard to understand the thinking or the reasoning of those who continue to insist that no progress has been made.

Chairman ANDERSON. Do you know anyone who is insisting that no progress has been made?

Mr. MILLS. Sir, I did not understand you.

Chairman ANDERSON. Do you know anyone who has insisted that no progress has been made?

Mr. MILLS. As I read Senator Gore's statement, he is a little impatient.

Chairman ANDERSON. He says not enough progress has been made. He does not say no progress has been made. That is quite a different thing, is it not? That is the difference between no progress and not enough progress. I think, if you would consult Mr. Searing, of Consolidated Edison, you would find out that this committee has encouraged him in every possible way, and we have applauded everything that he has done. I know I went out to speak to a group in New York one day and it had no connection whatever with what he was doing, and I did not even know that any representative of his companies were in my audience. I went out of my way to praise this fine example of what private enterprise was doing.

So I do not believe that we are opposed to this at all.

Mr. MILLS. I understand that Chairman Strauss in his testimony has given you his assurance that the fears expressed that America is losing atomic power leadership to other nations are groundless. I respectfully suggest that in view of the admiral's well-informed testimony, there seems to be absolutely no foundation for their assumption that America is falling behind in the nuclear power field.

In closing let me point out that this legislation is in contradiction to one of the stated objectives of the Atomic Energy Act, and I

quote, "strengthen our free competition in private industry." That objective is sound. We give it wholehearted endorsement and reaffirm that S. 2725 is completely incompatible with this policy. It would merely duplicate work already being done by private enterprise as speedily as is permitted under the law and under the rules and regulations of AEC.

This proposal to invest several million dollars of tax funds in an unnecessary Government program comes at a time when our economy and the social order it supports calls for prompt and substantial tax reductions. As a spokesman for an important group of these taxpayers, we feel that we have not only the right, but the obligation to ask your committee to adopt a policy that conserves the tax resources of our people for the essential and necessary functions of government.

It is our firm belief that the most rapid progress and the most productive use of this new energy source will be achieved not by spending the tax resources of the American people, but rather by permitting the operation of our free and competitive enterprise system.

Chairman ANDERSON. I will only observe that I do hope that you read the bill and think about it and try to find out if it is so full of this awful threat to American industry as you seem to believe.

Mr. Hopkins, who testified here this afternoon, is active in a fairly sizable business enterprise. He must not be a member of your organization, or any of his companies. But he thinks that it is a pretty good idea to try to keep abreast. He would build 50 plants. The Gore bill would build six.

I do not believe that that means that Mr. Hopkins is eight times as bad as you think the Gore bill is. I think he is a very nice man and a very shrewd man, and I think that he recognizes that he is going to lose his business enterprise abroad at least if there is not a continuing development of good reactors in this country.

I think that Mr. McCune, of General Electric, believes that we need to do something of this general nature.

Mr. McCune, it just happens—or General Electric, at least—at one time proposed the construction of almost what we have been talking about, a plant at Hanford to produce power.

He proposed it at a time—or the company proposed it at a time when the nation was not quite ready perhaps to do it. I still think it would have been worthwhile if we had done it. We would have learned a lot by what was proposed, and I think we would be further along in our atomic program had we done it. And I do not believe it would have jeopardized a single business enterprise in the whole State of New York. I could be wrong.

Mr. MILLS. Well, sir, the General Electric Co. is operating a nuclear facility close to where I live in Albany, N. Y., and I think that they are operating it for the Government.

Chairman ANDERSON. They are operating a still bigger one out at Hanford.

Mr. MILLS. When that power was turned on to the line—and again we inevitably seem to come back to the thing that we do not intend to talk about, and that is this preference clause——

Chairman ANDERSON. There is not a preference clause in this bill.

Mr. MILLS. But there was considerable agitation among the people like Mr. Patton and others who are supporting this bill because that was not made available under a preference clause provision.

Chairman ANDERSON. Well, you know more about it than I do. My thought was that the agitation came out of the fact that a certain Mr. Anderson who was the manager of that plant did not quite follow the provisions of the laws as we saw it in offering the power. It was not objecting to the final result, but if there is a law on the statute books, even though you do not like the law, you ought to live up to it or get out. He, I think inadvertently, did not live up to it because he did not believe anybody wanted the power, and in that he was quite right.

But instead of offering it to them, he called them on the telephone and said, "Would you like to buy from 1 to 50 thousand kilowatts of power at a rate that may be zero to 50 cents, and if so, how much would you take tomorrow?"

That is not an exact reproduction because he did not say it that bluntly, but he assured them no amount of power and no fixed rate and no assurance that he would deliver it to anybody at any time.

Would you, as a prudent businessman, bid for that? Of course you would not. And neither did the people connected with these preference customers.

As a result of it, he had to take back what he did, and start over again, and ask for the proper bids from preference customers, and then find out that they did not want it and now it is going exactly where he intended it to go in the first place. But the total proceeds from those sales have only been about $36.

If it had happened to go to a preference customer, I just cannot believe that the whole economy of New York State would have been shaken by it.

Mr. MILLS. I am inclined to agree with you.

Chairman ANDERSON. Thank you very much, you have been very patient.

Mr. MILLS. Thank you, Senator.

(The material submitted by Mr. Mills follows:)

COLUMBUS, OHIO, *May 28, 1956.*

WILLIAM A. MILLS,
Care Council of State Chambers of Commerce,
Washington, D. C.:

Ohio Chamber of Commerce concurs in testimony you are presenting Joint Committee on Atomic Energy re S. 2725 and authorizes you to also speak on our behalf. We request that you ask permission to file this statement with the Joint Committee on Atomic Energy for inclusion in the record.

Our board and membership look upon this proposal as an approach to Federal power production in an entirely new field and a serious threat to private power producers throughout the United States.

We are in agreement with the testimony presented on behalf of the Edison Electric Institute by Elmer J. Lindseth, president, Cleveland Electric Illuminating Co., who said it would "put still another agency of the * * * Government in the tax-exempt electric power business on a commercial basis in completion with taxpaying investor-owned electric companies."

We earnestly point to the fact that from 1946 to the present, the 8 major private electric power producers in Ohio have added new and additional generating capacity totaling 5,234,000 kilowatts at a cost of $755 million in Ohio alone. Also that, at their own cost, 15 private companies operating in Ohio, Pennsylvania, Kentucky, and Indiana contracted with the Atomic Energy Commission for the construction of new generating plants in Ohio and Indiana to furnish electrical energy for operation of the AEC uranium-235 production plant in Pike County, Ohio, and that these facilities are now in operation.

This is submitted as evidence that private enterprise, given the opportunity, can and will meet the expanding needs of the Nation.

HARRY W. ARNOLD,
President, Ohio Chamber of Commerce.

NEWARK, N. J., *May 29, 1956.*

WILLIAM A. MILLS,
Care Council of State, Chambers of Commerce:

The New Jersey State Chamber of Commerce is opposed to the enactment of S. 2725 and you are authorized to speak for our chamber when you appear at public hearing in Washington today.

IRVING T. GUMB,
Executive Vice President.

LITTLE ROCK, ARK., *May 28, 1956.*

WILLIAM A. MILLS,
Council of State Chambers of Commerce,
Washington, D. C.

This will authorize you to represent Arkansas State Chamber in your opposition to S. 2725, by Gore of Tennessee. Regards.

FRANK CANTRELL,
Manager, Arkansas State Chamber of Commerce.

DENVER, COLO., *May 25, 1956.*

WILLIAM A. MILLS,
Care the Council of State Chambers of Commerce,
Washington, D. C.

You are authorized to represent the Colorado State Chamber of Commerce in opposition to S. 2725 which means another flagrant, unwarranted encroachment on private enterprise at the taxpayers' expense.

BEN C. ESSIG,
Chairman, Legislative Affairs Committee,
Colorado State Chamber of Commerce.

GEORGIA STATE CHAMBER OF COMMERCE,
Atlanta, Ga., May 25, 1956.

Mr. WILLIAM A. MILLS,
Care of Council of State Chambers of Commerce,
Washington, D. C.

DEAR BILL: We authorize and request you to speak in behalf of the Georgia State Chamber, as well as your own organization, when you appear next Tuesday before the Joint Committee on Atomic Energy in opposition to Senate bill 2725.

This bill, as proposed by Senator Gore, of Tennessee, authorizes the Atomic Energy Commission to construct and operate six atomic reactors in as many different sections of the country to produce electric energy.

We feel that this is clearly another approach to Federal public power production and is a serious threat to the private utilities of our Nation.

The statement you have prepared for your Empire State Chamber has been carefully reviewed and we thoroughly concur in these opinions. You are kind to offer us this opportunity to be represented and we gratefully accept your offer.

Sincerely yours,

WALTER CATES,
Executive Vice President.

BOISE, IDAHO, *May 28, 1956.*

WILLIAM A. MILLS,
Care of Council of State Chambers of Commerce:

Please testify for Idaho against S. 2725.

EARL W. MURPHY,
Secretary, Idaho State Chamber of Commerce.

INDIANAPOLIS, IND.

WILLIAM A. MILLS,
Care Council of State Chambers of Commerce:

You may list Indiana chamber as approving your S. 2725 statement.

JACK REICH.
Executive Vice President, Indiana State Chamber of Commerce.

TOPEKA, KANS., *May 25, 1956.*

WILLIAM A. MILLS,
Care Council of State, Chamber of Commerce:

This will authorize you to speak for and represent the Kansas State Chamber of Commerce in opposition to the enactment of S. 2725 before Joint Committee on Atomic Energy.

C. C. KILKER,
Manager, Kansas State Chamber of Commerce.

MAINE STATE CHAMBER OF COMMERCE,
Portland 3, Maine, May 25, 1956.

WILLIAM A. MILLS,
% Council of State Chambers of Commerce,
1025 Connecticut Avenue, Washington 6, D. C.

DEAR BILL: I have read your proposed statement on S. 2725 with considerable interest, and want to compliment you on a good job done.

Please include the Maine State Chamber of Commerce with those supporting your testimony.

Cordially yours,

PAUL C. EMERSON,
Executive Manager.

MAY 28, 1956.

WILLIAM A. MILLS,
Care Council of State Chambers of Commerce, 1025 Connecticut Avenue., Room 513:

Please represent Missouri State Chamber in your testimony May 29 before the Joint Committee on Atomic Energy on S. 2725 which authorizes the Atomic Energy Commission to construct and operate atomic reactors. A basic policy of the Missouri State Chamber has long been that Government should not do what can be done by private enterprise.

JOHN R. THOMPSON,
Executive Vice President, Missouri State Chamber of Commerce.

MAY 26, 1956.

WILLIAM A. MILLS,
Council of State Chambers of Commerce, 1025 Connecticut Avenue, Room No. 13, Washington, D. C.:

The Montana Chamber of Commerce has consistently opposed business type operations by Government in fields where private enterprise can and are willing to operate. Please include this wire in your opposition of S. 2725 on this basis.

Thanking you,

WILLIAM H. BROWNING,
Manager Montana Chamber of Commerce.

MAY 28, 1956.

WILLIAM A. MILLS,
Council of State Chambers of Commerce,
1025 Connecticut Avenue, Room 513:

Please include East Texas Chamber of Commerce as one of those organizations for which you will speak before Joint Committee on Atomic Energy, Tuesday, May 29.

FRED POOL, *General Manager.*

MAY 28, 1956.

WILLIAM A. MILLS,
Council of State Chambers of Commerce,
1025 Connecticut Avenue, Room 513:

South Texas Chamber opposed S. 2725 in principle and hereby authorizes you to represent us in testimony against bill at committee hearing Tuesday, May 29.

H. E. NIX,
Executive Vice President, South Texas Chamber of Commerce.

WEST VIRGINIA CHAMBER OF COMMERCE,
Charleston, W. Va., May 25, 1956.

Mr. WILLIAM A. MILLS,
c/o Council of State Chambers of Commerce,
1025 Connecticut Avenue, NW., Washington, D. C.

DEAR BILL: President Robert G. Kelly of the West Virginia Chamber of Commerce has examined and approved on behalf of the West Virginia Chamber of Commerce the statement you propose to present on Senate bill 2725 to the Joint Committee on Atomic Energy of the United States Senate on May 29, 1956.

President Kelly is of the opinion that your proposed statement is in complete conformity with the several policy declarations of the West Virginia chamber dealing with questions of public power, and has asked me to officially express to you our appreciation of your willingness to permit us to subscribe to your statement.

With very best wishes for success in the important assignment you have undertaken, also with personal regards, I am

Sincerely yours,

H. A. STANSBURY,
Managing Director.

MAY 28, 1956.

WILLIAM A. MILLS,
Council of State Chambers of Commerce,
1025 Connecticut Avenue, Room 513, Washington, D. C.:

Would appreciate your representing us in opposing enactment of S. 2725 which to us is a new approach to Federal public power production.

GUS P. BACKMAN,
Secretary, Salt Lake City Chamber of Commerce.

Chairman ANDERSON. At this point we will insert the statement from the Metals & Controls Corp.

A report of the Edison Electric Institute committee on atomic power adopted by their board of directors.

A letter from Joseph E. Moody, president of the Southern Coal Producers' Association, and one from the Chamber of Commerce of the United States.

One from Charles B. Shuman, president of the American Farm Bureau Federation.

Letters from Ben Moreell, former Chairman of the Task Force on Water Resources and Power of the second Hoover Commission and one from R. L. Schacht, general manager of the Consumers Public Power District.

METALS & CONTROLS CORP.,
Attleboro, Mass., May 28, 1956.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
The United States Senate, Washington 25, D. C.

DEAR SENATOR ANDERSON: I wish to submit a suggestion concerning the reactor development program of the Atomic Energy Commission. I would be glad to have this letter included as part of the record of the current review of this program by your committee if you deem it appropriate.

In selecting the type of power reactor best suited to furnish heat for the generation of electric energy needed for important projects, foreign nations must give heavy emphasis to the continuing availability of the nuclear fuel required to keep the reactor operating. Such powerplants will be costly, long-term projects, and a high degree of assurance of continuing fuel supply will be essential.

Today, such nations must choose between two basic types of fuel—uranium enriched in varying degrees with U–235, and normal uranium. All United States reactors now being considered as electric power units in this country require enriched uranium fuel. None of the reactor types in the AEC reactor development program utilizes normal uranium. Hence, the foreign buyer who wants to buy an American model must accept the fuel availability conditions surrounding U–235.

On the other hand, the British model available for export uses normal uranium. It is probable that other European models will likewise be designed around the use of normal uranium, because only the United States has a substantial supply of U–235. The British have only enough U–235 for their weapons program. The enormous capital cost and electric power consumption for plants separating U–235 make it very unlikely that U–235 will be produced in other countries. The Soviet Union may be another source of U–235 for power reactors.

Let us consider the comparative conditions of availability of normal uranium and U–235. Uranium is being produced in large quantities in the United States, Canada, Belgian Congo, and South Africa. There is probably substantial production behind the Iron Curtain. At least moderate amounts are being produced in Australia, France, and Portugal. Significant discoveries have been reported in other countries. There seems to be fair assurance that many parts of the world may become producers of uranium in amounts which would be significant in terms of the needs for such nuclear fuel by smaller countries.

Normal uranium will presently be available from a number of sources and doubtless a world market and price will evolve. There is also always the reactor buyer's hope, and in many cases reasonable expectation, that uranium will be found within his own borders in amounts sufficient for his domestic needs.

In addition to its growing availability from a number of sources, normal uranium offers another attractive feature to our foreign buyer. It gives him the basis for entering the plutonium business at some future date. He may want to produce plutonium in the future either to "spike" his normal uranium reactor in order to increase its power output, or he may want it for a weapons program. To recover plutonium from his spent normal uranium fuel will be a costly enterprise. But he doesn't have to make the decision now. He can figure his power costs without plutonium credit, store his spent fuel under water as long as he likes, yet whenever he decides to go after the plutonium, it is there in storage waiting to be separated.

Now let's consider the comparative availability of U–235. The only source, except possibly for the Soviet Union, is the United States Government. Annual appropriations by Congress—over half a billion dollars a year—are required to buy 10 percent of the Nation's output of electric power and to supply the uranium feed and to operate the plants producing U–235. Annually a determination is made by the President of the allocation of this U–235 among the claimants—weapons, naval and aircraft propulsion units, research reactors, domestic power reactors, and power reactors for export. Moreover, numerous strings are attached to the U–235 fuel furnished by the United States. Spent fuel must be returned to the United States for recovery of unused U–235 and any plutonium. Inspection rights are asserted by the United States to insure that the buyer is not diverting any U–235 for a purpose that might give him a supply for weapons. The obvious penalty for violation of any of these conditions would be the withholding of fuel needed for continued operation.

The United States political leverage of control of the continuity of electrical energy supply in the buyer country is likely to be very distasteful to the buyer, and in many cases, may be unacceptable. Considering the uncertainties surrounding the continued production of U–235 in the United States and the vigor of the United States claimants for U–235, the foreign buyer is likely to feel himself the low man on the totem pole. Even if these risks were assumed, political risks of a brownout or blackout of local industry because the United States had withheld fuel needed to keep the powerplants operating, might be intolerable. And it is well remembered that the United States has at times brought economic pressure to bear on nations whose behavior has been repugnant to us.

It is obvious that if all power reactors required U–235 as fuel, the United States would have a position of monopoly (shared perhaps with the U. S. S. R.). But

this is not the case. The British Calder Hall reactor is reported to produce power at 9 mils/kilowatt-hour without plutonium credit. At least one of our leading reactor experts has stated that a natural uranium, heavy water reactor is exceedingly attractive as a central station power unit.

For the above reasons, I believe that one or more projects for the development of a natural uranium power reactor should be initiated by the AEC so that the United States may have within a few years one or more export models which can be offered on terms which are at least competitive as to fuel with the models offered by Britain and Western Europe and probably by the Soviet Union.

When the first AEC reactor development program was being formulated in 1948, the late Enrico Fermi urged the inclusion of a natural uranium project. Few people shared his confidence in this type then and little was done to push forward such a project before I left the Commission in 1950. Evidently the matter has been inactive during the past 6 years. If any part of United States reactor program deserves a crash effort, it seems to me it is the development of a natural uranium-fueled power reactor.

Sincerely yours,

CARROLL L. WILSON, *President.*

REPORT OF THE EEI COMMITTEE ON ATOMIC POWER ADOPTED BY THE BOARD OF DIRECTORS OF EDISON ELECTRIC INSTITUTE, NEW YORK, N. Y.

The United States is supreme among all nations in the development and use of electric energy. The electric power industry has been, is, and will continue to be forward looking in enlarging the supply of efficient, low-cost electric energy for the continuing benefit of all the millions of power users throughout our land. The record of progress in the use of fossil fuels gives proof of the creative ability of industry as well as the constant will to do a good job better.

Atomic power is now an acepted fact. Substantial progress in its development has been made. Further development is a challenge the electric power industry welcomes. Advance into the unknown is a characteristic of American industry, which has risked so much and gained so much for all America since Edison opened his Pearl Street Station.

The member companies of the EEI have spent, and are continuing to spend, millions of dollars to develop economic nuclear power. A total of 44 investor-owned companies are singly or in groups participating in the planning and building of nuclear powerplants. More than 300 million free enterprise dollars are involved in the planning, construction, and attendant research for these plants which together will have an ultimate capacity in excess of 1,100,000 kilowatts. A total of 113 utility companies are active in the atomic power field and have AEC access permits.

At its meetings on June 5 and 6 the committee on atomic power reviewed current activities in the field of atomic power, including the investigation of various reactors, the development of new reactor prototypes, and the carrying out of programs of design, construction and operation of large-scale reactors under the power reactor demonstration program of the Atomic Energy Commission and through straight license applications. The committee is of the opinion that the present reactor program with the United States, in which members of the industry are playing such a leading part, is a most impressive one from the standpont of variety, depth and scope.

In its original 5-year power reactor development program, the AEC selected 5 reactor concepts as being technically feasible and potentially capable of producing economically competitive nuclear power. Companies, individually or in groups, have announced their intent to build large-scale plants embodying four of these designs and actions toward this objective are proceeding in an orderly manner. The fifth concept is the basis for a large-scale construction project by a public power district.

Since the original 5-year program was established, the AEC has added two new reactor designs. AEC has announced that it has signed a contract with a reactor manufacturer for building a prototype of one of these and that it is negotiating with another manufacturer for a similar undertaking for the other. As these and other promising designs or variations pass the prototype stage, the industry will again take major responsibility for their large-scale development with private capital. Past experience clearly supports this.

The committee on atomic power believes it is important to point out that in the development of conventional electric power the unique genius of the American economy under free enterprise has given the United States undisputed world

leadership in electric power production over many decades, utilizing every available energy source. The committee urges the industry membership to reemphasize as a basic program its determination to carry out the same kind of development in atomic power. This will assure our continuing leadership in production of power by nuclear means and will make available to the people of the United States and its allies the benefits of such leadership.

In order to insure that there will be no basis for doubt as to whether every variety of reactor that should be undertaken, either in prototype, or in large-scale project, is being undertaken, the committee on atomic power is recommending the program set forth in the following resolutions adopted at its meeting on June 5 and 6:

1. *Resolved*, That the committee on atomic power recommend that the board of directors of EEI establish immediately and on a continuing basis technical appraisal task force on atomic power reactors for the purpose of reviewing various reactor types and designs and recommending to the member companies of the EEI those reactor types and designs which appear to have promise of feasibility for the production of electric power.

The committee on atomic power recommends that the technical appraisal task force on atomic power reactors consist of independent nuclear engineers and scientists and executives of EEI member companies and equipment manufacturing companies. The atomic power committee further recommends that an adequate sum of money be appropriated each year to finance the workings of the technical appraisal task force on atomic power reactors on a continuing, long-term basis.

The committee on atomic power considers that such a technical appraisal task force should be available not only to serve the members of the institute directly, but also to act as a liaison agency with the members of any evaluation groups that may be set up at the national level.

2. *Resolved*, That the committee on atomic power favors the formation of a national evaluation group to provide a continuing means for the scientific, engineering and economic evaluation of power reactor types and designs and selection of those reactor types and designs which merit development and construction.

3. *Resolved*, That the committee on atomic power recommend that the board of directors of EEI call a conference of company presidents, to be held at the earliest practicable date, for the purpose of reviewing the atomic power program in the United States, particularly the role the investor-owned power companies, and so that necessary decisions can be made on the means by which their further and continuing participation in this program on an expanded and accelerated scale may be brought about.

4. *Resolved*, That the committee on atomic power recommend that the board of directors of the EEI appoint a permanent full-time executive secretary of the committee on atomic power for the purpose, among others, of assisting that committee and the members of the institute in furthering the development of atomic power.

(All of the above resolutions were adopted by the board of directors of Edison Electric Institute this date).

WASHINGTON, D. C., *May 31, 1956.*

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
The Capitol, Washington, D. C.

DEAR MR. CHAIRMAN: The Southern Coal Producers' Association is composed of producers of bituminous coal in the southern coal fields. These producers are located in West Virginia, Virginia, Tennessee, and Kentucky and produce over 100 million tons of bituminous coal annually.

We wish to record our opposition to S. 2725 and similar proposals to adopt a "crash program" to build atomic electric generating systems by the United States Government.

We support the program for orderly research and development of experimental nuclear powerplants. We recognize the need for Government participation in experimental research in the development of nuclear power.

We do not believe the Government should go into the business of producing electric power for general public consumption in competition with private enterprise, through the establishment of commercial nuclear powerplants.

1. There is no emergency need for building such plants.

2. The construction of these plants would be a great burden on the taxpayers of this Nation.

3. At a time when the tax burden is at an almost impossible level, this program would eliminate a great source of future taxes, if not operated by private companies.

4. Such a "crash program" would, in all probability, cause the building of plants not fully justified by the economic need of the Nation.

Mr. Tom Pickett, executive vice president of National Coal Association presented a very able statement on this subject to your committee on May 28. We endorse his views.

We urge that the subcommittee report these proposals unfavorably.

Very truly yours,

SOUTHERN COAL PRODUCERS' ASSOCIATION,
JOSEPH E. MOODY, *President.*

CHAMBER OF COMMERCE OF THE UNITED STATES,
Washington D. C., June 4, 1956.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
United States Capitol, Washington, D. C.

DEAR SENATOR ANDERSON: The Chamber of Commerce of the United States opposes S. 2725 on the grounds that it would act as a deterrent, rather than a stimulant, to private participation in the peacetime use of the vast source of energy contained in the atom.

The chamber believes that S. 2725, which would authorize the Atomic Energy Commission to construct six nuclear power facilities, would be contrary to the spirit of the Atomic Energy Act of 1954. The interests of all the people would best be served by relying on private enterprise to develop atomic electric power.

Production of electric power from nuclear materials, for sale to the people, should be the responsibility of investor-owned utilities and local agencies. The Federal Government should not enter into commercial exploitation of the use of atomic energy.

Private industry repeatedly has expressed willingness to invest many millions of dollars in the development of atomic electric power. It has not been the lack of initiative on the part of investor-owned utilities and equipment manufacturers which has delayed rapid construction of nuclear facilities; rather, it has been excessive governmental regulation and redtape and the necessity to find solutions to technical problems.

For example, developers of atomic electric power should be exempted from the Public Utilities Holding Company Act of 1935, as provided in S. 2643, now pending before the Senate Committee on Interstate and Foreign Commerce.

The extent of this problem is manifest in the months of delay experienced by private firms in their attempts to obtain licenses, clearances, construction permits, and fuel allotments from the AEC.

The Atomic Energy Act of 1954 offered private industry the challenge of developing atomic energy, and within 7 months the AEC began receiving proposals by private utilities to build nuclear reactors for power purposes.

This expressed willingness, and ability, of private industry to construct and operate the various types of nuclear power reactors seems to preclude the necessity for the Federal Government to enter directly into this field. Such Federal intervention would merely duplicate the efforts already launched by industry.

Because of these reasons, the national chamber sees no need for S. 2725 and urges you not to approve it.

I would appreciate it if you would make this letter a part of the record of your committee hearings on S. 2725.

Cordially yours,

CLARENCE R. MILES.

AMERICAN FARM BUREAU FEDERATION,
Chicago, Ill., May 25, 1956.

Re S. 2725 and H. R. 10805—Authorizing Federal construction of six regional nuclear power facilities.

Congressman MELVIN PRICE,
Member, Joint Committee on Atomic Energy,
House Office Building, Washington, D. C.

DEAR CONGRESSMAN PRICE: At the last annual meeting of the American Farm Bureau Federation the voting delegates of the member State Farm Bureaus reaffirmed the following policy:

"The production, transmission, and distribution of power should be primarily a function of private enterprise, either cooperative or noncooperative. The entry of the Federal Government in the power business should be restricted to those instances where adequate development cannot be had otherwise."

Concern has been expressed that the authorization for private enterprise to engage in the production of electric power from fissionable material has not yet resulted in the construction and operation of private nuclear powerplants. This can, we believe, be accounted for (1) by the fact that it is less than 3 years since the Congress authorized the entry of private enterprise in the nuclear power business, (2) by the fact that in the United States power produced from nuclear sources is still more expensive than power produced from fuel, whereas the reverse may be true in some other countries, and (3) by the fact that technology in this field is advancing so rapidly that investment at this time is made in the face of the fact that any plant will likely be obsolete before it is completed.

Even so, however, we understand that the Atomic Energy Commission has granted about a dozen licenses for private development of nuclear power. These include operations of various sizes and types. Since the 1954 act was approved the Atomic Energy Commission has been engaged in working out arrangements with private companies for the commercial production of electric power from fissionable materials, in plants of various types and sizes. We understand that final clearance authorizing some companies to proceed with construction of plants was only issued a few weeks ago. In other instances such final approval has not yet been issued. This does not mean that private companies have been idle during this period. We understand that substantial amounts of capital have been accumulated, skilled personnel employed, sites acquired, equipment ordered, and arrangements for contracting of construction negotiated.

The Atomic Energy Commission has authority to construct and operate pilot and experimental plants. The AEC has sole authority to license the use of fissionable materials by private companies and the design and size of facilities constructed for commercial power. The scientific knowledge acquired in the construction and operation of private commercial plants will be as fully available to the Atomic Energy Commission as though the Commission itself constructed the plants. We believe these functions and these authorizations prescribe the proper role of the Federal Government in this field.

The basic issue in this proposed legislation, as we see it, is should the Federal Government undertake the large-scale commercial production of electric power from fissionable materials in competition with private enterprise in a field in which private enterprise insists it is ready and anxious to move ahead?

It is our belief that the fullest and most economic commercial development of electric power from nuclear sources is best assured by leaving the primary responsibility for such development to private enterprise; and that the entry of the Federal Government into the nuclear power business, with its advantages of freedom from taxation and low or noninterest money, would tend to prevent full development in this field.

We do not see any compelling reason to support the development of a great many commercial nuclear powerplants so long as the status of the technology is such that electric power produced in nuclear plants on a commercial basis continues to be substantially more expensive than fuel power.

We believe that prior to any entry of the Federal Government in the production of electric power from fissionable materials (1) that adequate time should be provided during which private enterprise can demonstrate its capacity to develop this industry, and (2) it should be clearly demonstrated that private enterprise cannot and will not undertake this responsibility.

The American Farm Bureau Federation therefore respectfully recommends that no action be taken to authorize Federal investment in commercial production of electric power from fissionable materials at this time.

We plan to review this issue at our next board of directors meeting and may wish to file a supplemtntal statement with the Joint Committee on Atomic Energy at that time.

Very sincerely,

CHARLES B. SHUMAN, *President.*

PITTSBURGH, PA., *May 28, 1956.*

HON. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Senate Office Building, Washington, D. C.

SIR: As former Chairman of the Task Force on Water Resources and Power of the Second Hoover Commission, I feel it is my duty to bring to the attention of the Joint Committee on Atomic Energy my views with respect to S. 2725, a bill which would authorize and direct the construction by the Atomic Energy Commission of six nuclear power facilities for the production of electric power.

The studies and investigations carried out under my direction for the Second Hoover Commission convince me that this bill, if enacted into law, would constitute an unwarranted financial burden on the taxpayers of this country and that the procedure envisaged by the bill is not necessary to accomplish its purposes, as these are already being accomplished under existing procedures.

Furthermore, the legislation would provide for a further intrusion of governmental activity into a field which is beyond the proper scope of Government. It would set a dangerous precedent in that it would provide for the generation and sale of power as an end in itself, something which has not heretofore been done.

The Hoover Commission task force in its studies of Government activities in the field of electric power development and transmission encountered frequent statements to the effect that if the Federal Government did not undertake certain developments they would not be undertaken at all, and there would result a power shortage. Actually, the record shows that whereas the Federal investment in electric power projects from the beginning of its program in 1906 up to June 30, 1953, was only $2.3 billion, the privately owned investor-financed power companies have expended $21 billion on electric power projects since the end of World War II. There is no reason to believe that economically sound projects will not be undertaken with private capital.

Furthermore, as of today, the only power shortage areas in the country are those where the supply is under public ownership, i. e., in the area served by the Tennessee Valley Authority, the State of Nebraska, and the Columbia River Basin.

There are two principal reasons for these shortages. The first is that the expansion of service is dependent upon legislative action, where political considerations must be taken into account in addition to the economic factors. This results in inordinate delays and sometimes rejection of projects. The second reason is that, since the power is sold at subsidized rates which are well below those which have to be charged by privately owned competitors who must meet all costs, including local, State, and Federal taxes, and pay a return on investment, there results an unnatural stimulation of demand in excess of that which would exist if the power were sold for what it is worth.

Our task force found that all public power is subsidized. The subsidy takes one or more of the following forms which are evidenced in lower power rates:

(*a*) Use of interest rates which are lower than the actual cost of long-term money and risk capital;

(*b*) Omission of interest during construction;

(*c*) Omission of Federal income taxes or comparable contribution to the cost of the Federal Government;

(*d*) With two exceptions (Hoover Dam and TVA), omission of State or local taxes;

(*e*) Charging administrative costs, insurance and pensions to other Government accounts.

The Atomic Energy Act of 1954 provides that in the sale of electric power by the Atomic Energy Commission, preference shall generally be given to public bodies and cooperatives. Our task force studies indicated that the preference clause is grossly unfair to the vast majority (some 80 percent) of our citizens. Preference policy in effect makes any customer of a non-public-owned utility a second-class citizen so far as Federal power is concerned. The company from which he buys power is denied Federal power. His neighbor across the road or in the next town, served, by a cooperative or a municipality, gets power for less than true cost, while he in his electric rate pays local, State and Federal taxes in a greater amount because his neighbor pays nothing toward these ends.

I am informed that there are already in various stages of accomplishment some 89 nuclear reactors in the United States as compared with 63 in the other countries of the world. There are reactors of all types in the United States program. These include at least 4 types that are not known to be planned anywhere else. Such a comprehensive program does not warrant Federal competition in this field, especially since such competition would act to deny to the privately owned investor-financed program the scarce skills which are needed. Such competition would also be unfair to the great number of investors whose savings, insurance, and pension funds are used to finance the taxpaying private enterprises.

The proposed construction of the six reactors would serve to place the Federal Government in competition with private industry in the electric power field. This raises the question whether the Government should enter private industry in competition with its own citizens. If it can do so in one business, why not in any business? Under the armor of sovereignty, Government has advantages which preclude fair competition with nongovernmental entities. There is no reason to believe that any business—oil, steel, automobiles, or whatnot—could compete with a Government-subsidized operation.

It is my considered opinion that the intrusion of the Government into the field of power generation and transmission would constitute a long step forward on the road to public ownership of transportation, communication and all other public utilities and would set a precedent of far-reaching import in all of industry.

Sincerely yours,

BEN MORRELL.

CONSUMERS PUBLIC POWER DISTRICT,
Columbus, Nebr., May 28, 1956.

Subject: S. 2725 (Gore bill).

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
The Capitol, Washington, D. C.

DEAR SENATOR ANDERSON: I regret that it appears impossible for me to personally appear at the public hearings in connection with the legislation proposed by S. 2725; however, I do appreciate the opportunity to file a statement of my views.

By way of identification, the Consumers Public Power District, of which I am general manager, has had tentative approval from the Atomic Energy Commis-

sion in connection with the construction of a 75,000-kilowatt electric generating plant, utilizing a sodium graphite reactor (SGR) for the source of heat. Contract negotiations have been underway for several months between the Atomic Energy Commission, the North American Aviation, Inc. (the proposed builders of the reactor), and Consumers District. Although these negotiations are not yet formally completed, we believe they will be at an early date.

After having spent almost 2 years in the study of atomic power and a portion of that time in active contract negotiations on an atomic plant, I can fully appreciate the many problems involved and why a seemingly speedy solution of them is difficult.

The rapidity with which power reactors are constructed and placed in operation is a matter for Congress to determine, as it involves considerations beyond the development of economical electric power in various areas of the United States. I feel that where private industry, including public power agencies such as Consumers District, are carrying large financial risks in these atomic power programs, they are, of necessity, going to proceed more cautiously than the Federal Government would under a "crash" type of program where costs are of secondary importance.

A willingness on the part of the Federal Government to shoulder a larger portion of the financial risks will have a corresponding effect upon the speed with which the present program can proceed. Such a modification would still retain the advantages of bringing the experience and know-how of seasoned utility operators into this important demonstration phase, and of reducing the Federal capital expenditures required over that for a complete Federal program.

The program contemplated by S. 2725 need not be a replacement of the present program in which many public power agencies, such as Consumers District, feel that they can make a wortwhile contribution to the development of economical nuclear power. It can well supplement the work now underway by increasing the Federal participation in construction and operation of other types of reactors, particularly when the promise is great but the development work is not as far advanced as in some of the better known concepts of today.

Such a modification might well be a necessary and satisfactory supplement to the existing program where our organization feels it can contribute something of real value to this country and its problems.

Very truly yours,

R. L. SCHACHT, *General Manager*

Chairman ANDERSON. At my request the following telegram was sent to 42 potential industrial contractors of national reputation as to whether they could undertake responsibility in whole or in part for an additional prototype reactor project in the event Congress authorized an accelerated program. Thirty-nine replies were received and are set forth after the telegram.

(The telegram sent was as follows:)

In connection with consideration by Joint Committee of proposals for acceleration of civilian reactor program, the following information would be appreciated: (1) Does your company have any experience in the atomic-energy program? (2) If the Government undertook to design and construct one or more additional prototype reactor projects, is your firm qualified to assume full or partial responsibility for carrying on such a project under prime contract or subcontract? If partial responsibility, please indicate what part of a reactor project you could undertake. (3) Do you know of any other firms which might make a contribution to a reactor project?

(The following are copies of replies received:)

(1) The following AEC contracts have been or are being performed by ACF Industries, Inc.: AT (29–1)–1323, AT(29–1)–1352, AT(29–2)–207.

ACF's now engaged in designing and constructing reactors for Massachusetts Institute of Technology and for the National Committee for Nuclear Research of the Italian Government. A contract is now being negotiated with another foreign government for a research reactor of the most modern type.

(2) ACF Industries, Inc., is qualified to assume full responsibility for carrying on reactor design and construction program.

(3) ACF Industries has a list of qualified subcontractors who supply various components associated with nuclear reactors. A brochure describing our facilities, and technical literature indicating the types of reactors we are presently proposing to domestic and foreign customers are available upon request.

ACF Industries, Inc.

Answers to your wire June 1, 1956: (1) Alco Products, Inc. is building the Army package power reactor at Fort Belvoir, Va., and is currently working on three engineering study contracts involving reactors and their design. (2) Alco Products qualified to assume full responsibility for the design and construction of a twenty- to twenty-five-thousand kilowatt prototype reactor project or the nuclear engineering work for larger reactors. (3) Reference can be made to Nucleonics annual issue for a listing of all organizations which could contribute to a reactor project.

Alco Products, Inc.

The following answers your telegram received May 29, 1956:

(1) Allis-Chalmers has considerable experience in the atomic energy program. Currently participating in major projects: IE, APDA, PRDC, EBWR, and FNPG. Also furnishing major and auxiliary components for a number of other projects.

(2) We are qualified to assume full responsibility for a project under prime contract. Certain phases of the project would have to be carefully reviewed in the light of present commitments. We would expect to subcontract some parts to other specially qualified firms.

(3) There are a number of other firms which might make a contribution to a reactor project in varying degrees of magnitude. We have had the assistance of other companies as subcontractors and suppliers of basic materials, design, and components. Further details can be made available if desired.

Allis-Chalmers Manufacturing Co.

Regarding your telegram American Radiator & Standard Sanitary Corp. has broad experience in the atomic energy program as a supplier of many types of highly specialized atomic energy equipment and is currently engaged in the design of several nuclear reactors for electrical power generalization. In its atomic energy operation American-Standard has a large group of highly qualified and experienced technical personnel together with supporting manufacturing facilities for this type of work. If the Government undertook to design and construct additional prototype reactor projects, American-Standard is technically and financially qualified to assume full responsibility as a prime contractor for such work and has available scientific personnel that could be assigned immediately to any project of this nature.

American-Standard, Atomic Energy Division.

Austin Co. does have extensive experience in design and construction in the atomic energy program. The Austin Co. is qualified to assume full responsibility for carrying on a prototype reactor project as a prime contractor.

Austin Co.

Reference your wire May 29 subject consideration by your committee of proposals for acceleration of civilian reactor program. First: Bechtel Corp. has experience in atomic-energy program and are currently engineers constructors for General Electric on Commonwealth Edison Dresden nuclear powerplant.

Second: We are qualified to assume full design and construction responsibility for a reactor project requiring only the type of technical collaboration which is primarily available from prime manufacturers of reactor and nuclear components. Our availability is subject to timing of project and subject to prior commitments of our engineering and technical personnel.

Bechtel Corp.

Reurtel concerning acceleration of civilian reactor program, Bendix Aviation Corp. supplies following information:

(1) Bendix has extensive experience in atomic-energy program through operation of AEC plant in Kansas City, study of nuclear powerplants, design, and construction of nuclear components for both power and research reactors.

(2) Bendix could undertake design and construction of prototype reactor projects by assuming full or partial responsibility as a prime contractor or a major subcontractor.

(3) Regarding other firms in this field, Bendix would prefer to make no specific recommendations.

BENDIX AVIATION CORP.

In answer to your telegram of May 31, 1956, we are pleased to assist the Joint Committee on Atomic Energy with the requested information.

1. Blaw-Knox has had extensive experience in the atomic-energy program, having been continuously engaged as prime or subcontractor for the Atomic Energy Commission since 1946, and is currently active on major projects in the civilian atomic field.

Our experience as engineers and constructors covers a wide range of major projects for the Atomic Energy Commission, including feed materials plants, chemical separation plants, the materials testing reactor, and the components of power reactors.

2. Blaw-Knox has adequate staff and facilities to assume prime responsibility for the engineering and construction of the nuclear and heat-generation portion of a prototype reactor project. For a complete atomic powerplant, Blaw-Knox would collaborate with concerns that are expert in the power-generation field and with whom Blaw-Knox has been associated in the past.

3. In our work in the atomic-energy field, Blaw-Knox has been associated with many concerns which are eminently qualified to make major contributions to a reactor-prototype project. Westinghouse Electric Corp., General Electric Co., Babcock & Wilcox, and North American Aviation Co. are firms that fall in this category and are those with whom Blaw-Knox would collaborate most effectively in handling a complete atomic-power project.

We appreciate your consideration of Blaw-Knox in this inquiry and trust that the information we are able to give will prove helpful. We welcome the opportunity to be of additional assistance if the need arises.

Very truly yours,

BLAW-KNOX CO.

Your telegram requests information concerning our interest in the subject program. We have given answers following each question asked.

1. Does your company have any experience in the atomic-energy program?

Burns & Roe, Inc. has had experience in the atomic-energy program. We are currently working on the following projects:

(*a*) Shippingport steam electric station for the Duquesne Light Co. Construction and engineering as required for Duquesne Light Co.'s part of this project.

(*b*) Green Salt plant, Weldon, Mo. Subcontract work for Blaw-Knox Corp.

(*c*) ANP scoping assignment for Pratt & Whitney Aircraft Division of United Aircraft Corp.

(*d*) In addition to the above Atomic Energy Commission work, we have an assignment from a leading equipment manufacturer to provide preliminary design of the capitalized cost for a 100,000 kilowatt nuclear powerplant.

2. If the Government undertook to design and construct one or more additional prototype reactor projects, is your firm qualified to assume full or partial responsibility for carrying on such a project under prime contract or subcontract? If partial responsibility, please indicate what part of a reactor project you could undertake.

(*a*) Burns & Roe is capable of carrying on an atomic-energy project on a prime contract basis. As the prime contractor, we might either have subcontractors, or form a joint endeavor with other firms, where such action was desirable. We have on our own staff engineers who are familiar with reactor design and components of a nuclear powerplant. From past experience, Burns & Roe is completely qualified to undertake the engineering and design of a power reactor project.

(*b*) We have engineered, designed and/or constructed steam-electric generating stations whose combined capacities exceed 2 million kilowatts. We are enclosing printed information to illustrate a few of these powerplants.

(*c*) For the last 10 years we have also designed test facilities for the aeronautical field, and the total capital cost of completed projects exceeds $200 million. Enclosed is printed information to illustrate a few of these projects.

3. Do you know of any other firms which might make a contribution to a reactor project ?

There are undoubtedly many other good engineering firms which can and have made a contribution to reactor projects. However, we are not in a position to make recommendations.

If more detailed information is desired, we will be pleased to elaborate.

Sincerely yours,

BURNS & ROE, INC.

Question 1. Does your company have any experience in the atomic-energy program? Answer. Yes, our company has been engaged as both prime and subcontractor on AEC work since 1945. Currently have senior engineer employee in attendance Oakridge School of Reactor Technology with others following. Actual experience in fabrication of reactor components. Joint venturer in proposals to AEC for design, fabrication and construction of complete reactor installations. Currently have approximately 60 Q cleared administrative, engineering, shop and field construction personnel. Have access permit. Self-engaged in studies.

Question 2. If the Government undertook to design and construct one or more additional prototype reactor projects, is your firm qualified to assume full or partial responsibility for carrying on such a project under prime contract or subcontract. If partial responsibility, please indicate what part of a reactor project you could undertake. Answer. Our company qualified to carry on prototype reactor projects as a prime contractor; however, depending on the basis requirements, might prefer to join with other companies as we have previously in proposals to Atomic Energy Commission and also the Army. Your inquiry of great interest. It will be our pleasure to furnish more detailed qualification information when required.

CONSOLIDATED WESTERN STEEL, DIVISION UNITED STATES STEEL CORP.

Retel civilian reactor program, following are answers to information requested:

(1) Yes, but limited.

(2) Partial responsibility as follows: Design and construction of complete structures, buildings and services for reactor (reactor itself to be designed and built by others).

(3) Only companies undoubtedly already well known to committee.

DAY & ZIMMERMANN, INC.

Question 1. The Dow Chemical Co. has had extensive experience in atomic-energy programs. We designed and operate the Rocky Flats plant of AEC. We have done extensive research on ore processing, purification of feed material, high-temperature material for construction, processing of spent fuel elements, as well as studies for the AEC on the L. M. F. R. Our staff director, Dr. J. J. Grebe, has attended the Oak Ridge reactor school and has been a consultant for several agencies and companies. In the atomic-energy field, we have a large scientific staff, a core of nuclear physicists, and competent and sizable engineering department. We were one of the first companies to enter on reactor studies for civilian use. We own and operate a Van De Graaff accelerator.

Question 2. We feel competent as a prime contractor in the field of our major interest which are the L. M. F. R. and in the chemical facets of the civilian reactor program.

Question 3. Our experience with Babcock & Wilcox, Bechtel Corp., General Motors, and North American Aviation would lead us to believe that all have background which would be valuable in such a program.

THE DOW CHEMICAL CO.

Re telegram May 29. (1) We presently are contractors for the construction of the nuclear portion of the Shippingport atomic powerplant and our pipe-fabricating facilities are fabricating the pipe for the nuclear plant; likewise have pipe-fabricating contracts for other atomic projects. (2) We are capable of performing any and all construction services and providing any field engineering required to construct complete nuclear powerplants.

DRAVO CORP.

With regard to your telegram concerning consideration by a joint committee of proposals for acceleration of the civilian reactor program, we are pleased to give you the following information:

1. Our company does have certain and limited experience in the atomic-energy program. This experience has been in connection with the furnishing of classified components for the gaseous diffusion plant at Oak Ridge, Tenn., the construction of certain electromagnetic pumps for liquid sodium primary loop coolant, the development of a special shaft seal for primary loop water pumps, and the furnishing of more or less standard motors and pumps as auxiliary equipment.

2. Fairbanks, Morse & Co. has a large staff of engineers skilled in various phases of electrical, hydraulic, and mechanical engineering but does not have a nuclear engineering staff as such, although we do have quite a few of our engineering staff cleared for various phases of atomic-energy work. We would say that we would not be qualified to assume responsibility for carrying on a project in connection with prototype reactors as a prime contractor. We would say further that perhaps our principal interest would be in the supplying of component equipment where the design of such equipment has already been accomplished.

3. With reference to the third question of your telegram, we would say that there are a great many firms which are in a position to make a contribution to a reactor project. This is a growing industry and most of the large manufacturing firms in the country, as well as a great many of the smaller firms, are interested in the reactor-development program.

Please let us know if we can give you any further information.

Sincerely,

FAIRBANKS, MORSE & CO.

In answer to your telegram concerning civilian reactors we are pleased to submit the following information on behalf of Morrison-Knudsen Co., Inc., and its subsidiary, the H. K. Ferguson Co.

Question 1. Does your company have any experience in the atomic-energy program?

Answer. We have had a wide variety of experience since 1944 in the engineering design and construction of atomic-energy plants. We engineered and built in cooperation with the Brookhaven reactor-design group, the Brookhaven reactor together with its laboratory facilities. We designed and built the thermal diffusion plant at Oak Ridge, Tenn. We built the cyclotron laboratory at Brookhaven and the foundations for the cosmotron, and we designed and built a waste-disposal tank farm at Hanford. We currently have a contract at Oak Ridge for the performance of an estimated $20 million of construction, modification, and maintenance work at Oak Ridge, Tenn. This includes work in area No. 5. We last year completed construction of the new uranium mill at Monticello, Utah. In addition, we have constructed a large number of industrial powerplants in the United States over the past 35 years, and many industrial and public-utility plants abroad.

Question 2. If the Government undertook to construct one or more additional prototype reactors, is your firm qualified to assume full or partial responsibility for carrying on such a project under prime contract or subcontract? If partial responsibility, please indicate what part of reactor project you could undertake?

Answer. We are competent to carry out a prime contract for the engineering and construction of a civilian power reactor. We are not qualified to design or fabricate the nuclear components. We would propose to subcontract the nuclear components, design, and fabrication to such firms as Nuclear Development Corporation of America, Babcock & Wilcox, General Electric, Westinghouse, AMF Atomics, Atomics International, Combustion Engineering, Foster Wheeler, Alco Products, Glenn L. Martin, General Dynamics, and any other qualified reactor designers.

Section 3. Do you know of any other firms which might make a contribution to a reactor project?

Answer. We believe the firms mentioned above are all competent to design the nuclear components of a civilian reactor. There are also companies who specialize in fuel elements, such as Sylvania; companies who specialize in control rod assemblies, such as Ford Instrument; companies who specialize in instrumentation, such as Minneapolis Honeywell and Bailey Meter; and companies who specialize in pressure vessels and heat exchangers. Other companies, of course, are qualified to act as prime or subcontractors. We presume they will speak for themselves.

Very truly yours,

THE H. K. FERGUSON CO.

Reference to your wire this date we reply as follows:

1. Yes; we have experience in the atomic energy program. We were the prime contractor and constructed the materials testing reactor at Arco in 1952. We submitted proposal jointly with Westinghouse Airbrake for appr at Fort Belvoir, Va., and were second low bidder and have made numerous studies and proposals for the civilian power reactor program.

2. Our company is qualified to assume full responsibility as prime contractor for one or more reactor projects. This includes design, procurement, erection, inspection, expediting, and all other phases involved. We would require outside consulting services for nuclear physics only to supplement our nuclear staff.

THE FLUOR CORP

The following is in reply to your wire of June 1, 1956, in which you request information in connection with consideration by the joint committee of proposals for acceleration of the civilian reactor program.

1. The Ford Instrument Co. has had experience in the design, development, manufacture, and testing of reactor control system components for the naval propulsion reactor systems; and has conducted some preliminary studies which culminated in a contract with the Commission for a feasibility study of closed cycle gas-cooled power reactor systems. We have submitted a proposal to the city of Holyoke for the design and construction of this type of reactor under the second round power demonstration reactor program. We have also submitted a proposal to the Maritime Administration for a design study of this type of reactor for use in the propulsion of a tanker. Both are currently being evaluated.

2. The Ford Instrument Co. is qualified and interested in assuming the full responsibility for carrying out a prototype reactor project. It should be pointed out, however, that portions of a reactor powerplant such as turbo machinery, generators, pressure vessels, and heavy piping, and architect engineering services would be let out on subcontract.

3. Since the list of firms which are apparently equipped to make a contribution to a reactor project is quite lengthy, we would suggest that you communicate with the Atomic Industrial Forum, 216 Madison Avenue, New York, N. Y. It is our opinion that they are better equipped to supply this list of firms.

We trust that this information is adequate for your immediate purpose. We will be happy to furnish such additional information as you may require.

Very truly yours,

FORD INSTRUMENT CO.,
Division of Sperry Rand Corp.

We respond to your telegram of June 1, 1956, with the following information:

The experience of the Foster Wheeler Corp. in the atomic energy program is described by the following listing of nuclear projects completed and underway:

1. Consultant to the Oak Ridge National Laboratory in their investigation of helium-cooled power reactors.

2. Consultant to the Westinghouse Atomic Power Division on heat transfer and fluid flow problems involved in the design of the submarine thermal reactor.

3. Consultant, designer, and fabricator to the Knolls Atomic Power Laboratory on the liquid metal heat exchanger test loops for the submarine intermediate reactor.

4. Designer and fabricator of a liquid metal heat exchanger for the mine safety appliance test loops.

5. Designer and fabricator of six steam generating units under contract to the Westinghouse Atomic Power Division for the Bettis Mockup, the Mark I at the National Reactor Testing Station in Arco, Idaho, and the *Nautilus*.

6. Architect-engineer for the Idaho chemical processing plant. As architect-engineer, Foster Wheeler supplied the process design, engineering, and inspection srvices.

7. Designer and fabricator of large cooling towers for the gaseous diffusion plant at Oak Ridge under contract to the W. L. Maxson Corp.

8. Designer and fabricator of 2 of the 4 boilers required for the pressurized water reactor, under contract to the Westinghouse Atomic Power Division. (Shippingport nuclear powerplant project.)

9. Nuclear power project program.

Foster Wheeler, since 1952, has been actively engaged in a study of nuclear power generation under contract with the Atomic Energy Commission. Full partners in the effort are the Pioneer Service & Engineering Co. of Chicago, Ill., and the Diamond Alkali Co. of Cleveland, Ohio. Project consultant is Dr. T. H. Pigford of the Massachusetts Institute of Technology.

The first year was spent by the group in reviewing existing and proposed reactor designs suitable for power production.

In the second year, the group investigated the feasibility of a fluidized solids reactor. Several experiments, conducted in both the Foster Wheeler and Diamond Alkali Laboratories, showed that this system did not have the desirable nuclear and mechanical characteristics that stable nuclear power reactors require.

The group has just completed a reference design for a homogeneous power breeder. Various nuclear parameter studies were completed with the aid of the ORACLE at ORNL, and meetings with possible vendors are underway to determine costs. The homogeneous power system is now being offered to utilities.

10. Fabricator of 50 large heat exchangers for the Savannah River project under contract to E. I. du Pont de Nemours & Co.

11. Developer of designs and manufacturing techniques for steam generators for the homogeneous reactor program at Oak Ridge under contract with Carbide & Carbon Chemicals Co. The contract includes the design, construction, and operation of a thermal shock test loop.

12. Fabricator of 2 steam generators for the homogeneous reactor test at Oak Ridge.

13. Designer and fabricator of a model steam generator and pressurizer for the homogeneous reactor test mockup at Oak Ridge.

14. Fabricators of chemical processing plant components for Hanford under contract with the General Electric Co.

15. Designer, fabricator, and operator of a thermal shock test loop for the Westinghouse Atomic Power Division.

16. Designer, fabricator, and operator of the Livermore pool type reactor for the United States Atomic Energy Commission.

17. Designer and fabricator of the pressurizer for the pressurized water reactor under contract to the Westinghouse Atomic Power Division (Shippingport nuclear powerplant project).

18. Designer and fabricator of the steam generators and reactor vessel for the large ship reactor, under contract to the Westinghouse atomic power division.

19. Designer, fabricator, and erector of a large liquid metal heater for the Pratt & Whitney division, United Aircraft Corp.

20. Conceptual design of a fast reactor type nuclear powerplant utilizing pyrometallurgical processing techniques. Personnel undertook control and parameter studies.

21. Feasibility study of a MTR type powerplant for a remote location. Personnel participated in the nuclear parameter studies.

22. Fused salt package feasibility study for use at a remote location. Personnel undertook heat transfer and transient assignments.

23. Various transient studies for a submarine reactor project.

24. Massachusetts Institute of Technology Project Separation, 1954. This project entails a study of chemical processing techniques suitable for nuclear reactor fuels. Personnel participated in the engineering and economic evaluation section.

2. Should the Government undertake to design and construct one or more additional prototype reactor projects, our firm is qualified and prepared to undertake full responsibility for carrying out such a project as prime contractor, or to assume partial responsibility as a subcontractor for the design,

fabrication, and installation of the reactor loop, or components thereof, such as reactor vessels, heat exchangers, pressurizers, and other fabricated items.

3. Other fabricators of heavy pressure vessels and heat exchangers, like ourselves, should be capable of supplying nuclear plant components.

Yours very truly,

FOSTER WHEELER CORP.

In answer to your telegram of June 1, 1956, relative to the ability and qualifications of our company with respect to the atomic energy and nuclear reactor programs, may I give you our qualifications, as follows:

1. A few years ago we completed the original installation of the Atomic Energy Feed Materials Center at Fernald, Ohio. This work was done under the supervision of the then existent New York Atomic Energy office. Prior to that and during the war we performed the very secret work at Decatur, Ill., which plant was operated by the Houdaille Hershey Corp.

2. We have recently completed the construction work on the sodium reactor plant for the North American Aviation Corp. at Santa Susanna, Calif. This is one of the first private nuclear reactor plants to have been completed structurally.

3. Our organization, started in 1882 incorporated in 1901 under the laws of the State of New Jersey, has been continually active in all branches of construction work. During the war we were one of the most active contractors on war work, having done a tremendous volume for the Bureau of Yards and Docks, the Defense Plant Corporation, Army Air Force, and others.

While we do not sell ourselves as architects-engineers-contractor, we have in our employ competent architects and engineers, satisfactory to work with other complementing organizations for the completion of any type of project. Normally when requested for a "package deal" we solicit the help of independent architects and engineers to work with us on the development of plans, specifications, etc.

We will be only too happy to work with you on any new nuclear-reactor-development work throughout the country.

For your information we have well-established offices in Boston, Mass., Pittsburgh, Pa., Chicago, Ill., Los Angeles, Calif., Dallas, Tex., Atlanta, Ga., Washington, D. C., with our central office located here in New York. At the present time we are operating in 37 of our 48 States.

Very truly yours,

GEORGE A. FULLER CO.

This is in response to your wire of May 31.

Our firm has designed numerous atomic-energy plants, including reactor plants at Hanford Engineering Works, gaseous diffusion, and other plants at Oak Ridge, Paducah, and Portsmouth. We are qualified to assume overall responsibility for design of prototype reactor plants.

We are qualified, without outside assistance, to plan the general functional arrangement of such plants, completely design the heat exchanger, steam generation, and electrical systems, all architectural and structural work. For the design of the reactor and associated facilities handling nuclear materials, we would require the assistance of consultants.

We would be interested either in prime contracts under which we would retain consultants for those portions of the work outside our capabilities, or in subcontracts covering work within our usual scope of services.

We thank you for your inquiry.

Sincerely yours,

GIFFELS & VALLET, INC.

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1. The J. A. Jones Construction Co. has had more experience and more varied experience in the atomic-energy program than any other construction company. We began work under the Manhattan District at Oak Ridge in 1943, built a 235,000-kilovolt-ampere steam plant. This we built and put the first unit in operation in 10 months. Simultaneously we began construction of K–25 and K–27, installed all equipment and gave the equipment its preoperational run before turning over to Union Carbide & Carbon who had an operational contract.

We then modernized and built some new facilities at X–10 where the Oak Ridge Laboratory functions. We demolished S–50, which was highly radioactive.

We also handled considerable modernization and standby work for Y–12, the electromagnetic process plant.

We were then transferred by the Atomic Energy Commission to the Hanford engineering works where we have been handling either major construction projects or maintenance work continuously since 1946. We built some entirely new manufacturing plants and reclaiming plants, all highly technical, and rebuilt other manufacturing units. We have the largest number of highly trained electrical and mechanical engineers and mechanics who have been cleared for this type of work and who would be the nucleus of an expanded organization for any increase in this type of work.

2. The J. A. Jones Construction Co. has consistently shown more interest in the reactor program than any other construction firm in the United States. We put together a joint ventureship, consisting of ourselves, General Electric, and Chicago Bridge & Iron, and submitted to the Atomic Energy Commission a proposal to build with our own funds an engineering test reactor on the Saluda River, about 40 miles west of Columbia, S. C. We had options on the land, water rights, and the entire cooperation of the State government of South Carolina and the power company. We have reasons to believe the main reason this proposal was not accepted by the AEC was because the insurance feature had not been worked out to the extent it seems to be done at this time.

In this proposal for the ETR, the J. A. Jones Construction Co. was the sponsor, or managing partner, and we proposed not only to design or have designed, and construct, but also to manage the ETR. We had personnel lined up at that time thoroughly competent for the management functions, and believe we can do so again.

In addition to the above, on August 24, 1955, we submitted to the Atomic Energy Commision a proposal to construct the proposed ETR for Idaho Falls, Idaho.

To summarize, we have handled major construction projects at Oak Ridge, Tenn., and at Richland, Wash., and have proposed to design, construct, and manage the reactor to be located in North or South Carolina; and also to construct a reactor at Idaho Falls. Our interest is still keen in this atomic energy program and we hope that we can be used to the fullest extent.

In further answer to question 2, we can assume the full responsibility for such a reactor program or any part that the AEC would want us to handle. We would prefer to be the prime contractor. We are available for personal conferences at any time in connection with this program. We suggest that the proposal which we submitted to the AEC on the ETR for the Carolinas is available from their files and should be of considerable interest to you.

Thanking you, we are

Sincerely yours,

J. A. JONES CONSTRUCTION CO.

Re your telegram May 29 regarding our qualifications to participate in proposed civilian reactor program acceleration.

1. Kaiser Engineers has had experience in atomic-energy program including construction of large production reactor facilities at Hanford, design and construction of engineering test reactor at NRTS, and many smaller engineering and/or construction projects for AEC at Livermore, Lockland, NRTS, Inyokern. We also had nuclear power study agreement with AEC and have completed preliminary engineering designs of various reactor concepts for nuclear-power generation.

2. Kaiser Engineers is qualified to assume prime contractual responsibility for design and construction of reactor project. We would employ subcontractual assistance for reactor physics mathematics. In addition we might provide for certain special nuclear component design through vendors handling such equipment (for example, fuel components, control-rod drives, etc.). This is relationship we currently have with AEC on ETR turnkey.

3. Firms whom we consider qualified to assist us in such a project would be American Radiator & Standards, Internuclear Corp., NDA, AMF, B. & W., Atomics International, GE. We will submit to you within next 2 weeks special brochure pertaining to our qualifications to construction services. It is possible that other companies in Kaiser Industries affiliated to Kaiser Engineers might qualify to operate reactor facility as source of industrial power.

KAISER ENGINEERS.

Reference your wife May 29 M. W. Kellogg Co. through its subsidiary Kellex Corp., designed and engineered diffusion plant at Oak Ridge and has broad experience in all types of chemical processes involving design, engineering, procurement, and construction. We are fully qualified to assume complete responsibility as prime contractor. We know of no other company better equipped for contribution to studies of feasibility, design, and erection of this type project.

THE M. W. KELLOGG CO.

Re your telegram June 1, 1956: No. 1, we have just completed construction of the gaseous diffusion plant in Pike County, Ohio. This is approximately a $1 billion project completed 6 months ahead of schedule; No. 2, we feel that we are qualified to assume full responsibility as a prime contractor for construction of a reactor project; No. 3, we personally know of no other construction firms at this time who might make a contribution to the reactor project. We will be very pleased to meet with you to discuss further details relative our qualifications, experience, organization, financial background, at your convenience.

PETER KIEWIT SONS CO.

This will acknowledge your telegram of June 1.

Our comment on question 1 is that we have been building up a group dealing with this field for the past 18 months. At the present time we feel particularly competent to design, build, and operate uranium feed material plants. It is our intention to bid on the present AEC 5,000-ton uranium feed material on October 1. We are also acquiring a small group that have some training and experience in nuclear reactor design.

Question 2: If the Government undertakes to design and construct one or more additional prototype reactor projects, we feel that it will take some time before we can be qualified to assume full responsibility for carrying out such a project under prime contract. In this connection we have recently bid on the liquid metal fuel reactor experiment, and while we were not awarded the bid, we understand that we rated number two on the list of bidders. We should have one of these experimental study jobs to enable us to build up a competent staff.

We wish to warn you that in our opinion the country does not have enough scientific and engineering talent to undertake a greatly accelerated civilian reactor program and must advise you not to go too fast. If new plants are suddenly authorized, the major engineering firms will be forced to rob each other of experienced and talented men, thus slowing down the whole program.

Question 3. We cannot at this time give you the names of other firms which might make a contribution to a reactor project. We believe that there are already many in the field who have ambitions in that direction.

We hope to hear further from you, and if there is any additional information we can supply we will be glad to do it.

Sincerely yours,

KOPPERS CO., INC.

Re your wire (1) Arthur D. Little, Inc., has extensive experience in atomic-energy program, (2) Arthur D. Little, Inc., and affiliate Nuclear Metals, Inc., qualified to undertake fuel element and certain reactor component research development and prototype manufacturing work.

ARTHUR D. LITTLE, INC.

In connection with the receipt on June 4 of your telegram concerning proposals for acceleration of the civilian reactor program, it is our pleasure to answer your questions, as follows:

1. The Lummus Co.'s experience in the atomic energy program is connected with the following projects:

A. Design, engineering, and procurement of heavy water process facilities at the Savannah River plant.

B. Design, engineering, and procurement of a portion of the heavy water process facilities at Dana, Ind.

C. Design, engineering, and procurement of uranium recovery facilities for the Savannah River plant.

D. Design, engineering, and fabrication of acid recovery facilities for Hanford, Wash.

E. Under our access permit No. 472, we have been studying and investigating—
(a) Feed materials processes.
(b) Waste disposal methods.
(c) Fuel reprocessing processes.

F. At the present time we do not have any active AEC design or engineering work under contract.

2. We believe we are qualified to assume either full or partial responsibility for carrying out a prototype reactor design project. We believe we are especially qualified in the fields of feed materials processing, fuel reprocessing, and waste disposal. We are experienced in powerplant design and construction.

3. Other firms who might make a contribution to a reactor project and are in fact now doing so are Combustion Engineering Co. and Babcock & Wilcox Co.

THE LUMMUS CO.

In answer to your telegram of June 1 requesting information in connection with the consideration by the Joint Committee of proposals for acceleration of the civilian reactor program, we submit the following information for your appraisal.

Our company has had experience working with the application of atomic energy in the generation of electrical power for nonmilitary uses since the spring of 1954. At that time our company bid on the APPR proposal for the Army Reactors Branch of the Atomic Energy Commission. Since that time we have carried on work in the power package reactor field under our own initiative and have held various subcontracts and prime study contracts with the AEC.

Our prime interest has been in the packaged power field and the small power station unit type of power generation. We have been interested in pressurized water systems; however, we are now considering other types, mainly the gas cycle type.

We have developed a tubular fuel element which is now undergoing final testing. This element is not of a new concept; however, we are the first company to carry out development to this extent.

At the present time we are engaged in a classified prime contract with the Commission, a welding research study as a subcontractor with Union Carbide Nuclear Co. and undertaking development of nuclear power under our own initiative for pressurized water systems of varying enrichment.

If the Government were to undertake the design and construction of an additional prototype reactor project, we feel our firm would be qualified to assume complete and full responsibility for carrying out such a project under a prime contract. Certainly portions of a reactor project would be subcontracted to other companies; however, we have the technical manpower and background and financial responsibility to undertake a complete program.

Other firms which might make a contribution to a reactor project would be those companies with experience in the fields of construction, pressure vessels, electrical generation, and the like.

We appreciate your inquiry, and we hope that this letter will contribute the information you desire. If we may be of assistance to you in any way, please feel free to call upon us. We would be willing to make available to you at any time personnel from our organization for consultation or information about our activities.

Very truly yours,

THE GLENN L. MARTIN CO.

Reurtel June 2, Metals & Controls (1) has 4 years' experience fabricating fuel elements and fuel element components for atomic-energy programs; (2) could accept partial responsibility in expanded program of reactor projects for fabrication of fuel elements thereunder, either as prime contract or subcontract.

METALS & CONTROLS CORP.

Reurtel relative to civilian reactor program: (1) Our company has had considerable experience in engineering and construction in atomic-energy program. (2) Our company would be qualified to assume partial responsibility for carrying on prototype reactor projects. Our responsibility would include design engineering and construction of structures and mechanical work, but would not

include design of reactor itself. (3) I believe you would get a very comprehensive answer to question 3 by referring to the Atomic Industrial Forum, 260 Madison Avenue, New York, or to Mr. Walker L. Cisler, president of the Detroit Edison Co.

Additional information on our company will follow by mail.

F. H. McGRAW & Co.

Reurtel June 1, received yesterday, we are pleased to furnish the following information:

1. McKee is now executing second subcontract with Westinghouse atomic-power division, prime contractor to AEC, for design of expended core facility. First subcontract was design of auxiliary facilities for A1W, prototype for large ship reactor. Organization includes engineers with experience on ANP program, projects at Hanford Works and Knolls.

2. McKee is qualified to assume responsibility for prototype reactor project as prime or subcontractor with collaboration of one or more firms listed in item 3. McKee could undertake engineering of all auxiliary facilities including containment vessel, reactor auxiliaries, cooling water system, building structures, laboratories, shops, site development, personnel, and administrative facilities.

3. Other firms which would contribute to prototype reactor project and with which we have made arrangements to collaborate include Westinghouse, General Electric, or Babcock & Wilcox on reactor proper, and Brown Instrument or Leeds & Northrup on reactor instrumentation.

Please advise if further information is required.

ARTHUR G. McKEE & Co.

Question No. 1

Nuclear Science & Engineering Corp., organized in 1954 and located in Pittsburgh, Pa., is already an important organization in the nuclear field. NSEC is a service research and development organization dedicated to fulfilling the needs of the rapidly growing nuclear power industry and to helping all industry to exploit fully the industrial applications of radioactivity.

The firm is staffed with leading scientists—chemists, physicists, health physicists, biologists, and engineers. It ha a comprehensive network of laboratory facilities, including a general radiochemical laboratory, a radiobiology laboratory, a physical laboratory, a darkroom and two counting rooms, and both low-level and semihot laboratories. It is fully equipped to offer a large range of services from fundamental and applied research and development through technical services like nuclear measurements in the fields of chemistry, physics, engineering, biology and medicine; analyses; design; and testing. It can operate purely on a consultative basis, supplement clients' engineering staffs with the services of its specialists, or utilize only its own staff and facilities to fulfill clients' needs. In both staff and physical facilities, the corporation is oriented to render services in the field of nuclear-power deevlopment and to industry in general. This scope is further broadened by the fact that the organization's services are also utilized by universities, hospitals, museums, insurance companies, and reearch institutes.

As a service research and development operation, we are working together for the great many companies directly involved in the field of nuclear power, as well as those interested in the industrial applications of nuclear techniques. Hence, our basic nature is such that we have a rather central position from which to view developments in the atomic energy field. This continually strengthens the judgments and capabilities of the staff.

NSEC is now the only commercial producer of carrier-free cyclotron produced radioisotopes in the United States.

NSEC has a prime contract with the Commission to study all of the waste disposal techniques that are in effect or being developed by the nuclear industry.

NSEC staff can assist in writing a feasibility report and devise appropriate accountability procedures to cover the SS nuclear material control. This effort involves:

(*a*) Integrating accountability functions into line organization.
(*b*) Designing approximately 20 accountability forms.

(*c*) Prepare a procedure manual, in conjunction with your facility that will cover the contemplated operations. This manual will delineate the following:

(1) Organization of material control persons.
(2) Accounting records.
(3) Statistical control.
(4) Analytical methods for assaying SS materials.
(5) Reporting procedures.
(6) Step by step material control.
(7) Security provisions.
(8) Criticality precautions.
(9) Health physics precautions.

(*d*) Formal request for a special quota for SS materials.
(*e*) Establishment of an accountability station.
(*f*) Set up necessary books.
(*g*) Establish reporting procedures for required monthly reports to the Commission.
(*h*) Training accoutability personnel.

Nuclear Science & Engineering Corp., in conjunction with its client will develop appropriate criticality precaution procedures to preclude the possibility of inadvertently forming a critical mass in the course of production. NSEC scientists have developed procedural techniques so that a production person (who may not be familiar with involved criticality calculations) can safety execute required precautions.

Routine low-level radiation monitoring and service is now being supplied to industry from the Nuclear Science & Engineering Corp. the usual background of the instrument is 0.5 cycle per minute enabling the counting of samples containing activities below ambient levels; 8 inches of iron and 1 inch of mercury shielding, plus an anticoincidence counting circuit are used to obtain this low background.

Question No. 2

Under the present scope of interest of NSEC it is not anticipated that the corporation will participate as a prime or subcontractor in the design and construction of nuclear reactors.

Question No. 3

Westinghouse Electric Corp., North American Aviation, Nuclear Development Associates, General Electric, Olin Mathieson Chemical Corp., Combustion Engineering, Inc., Babcock & Wilcox, Convair, etc.

Your interest in Nuclear Science & Engineering Corp. is indeed appreciated. If there is any additional information you may require, please get in touch with me.

NUCLEAR SCIENCE & ENGINEERING CORP.

Item 1: In response to your telegram, we wish to assure that the Ralph M. Parsons Co. is extremely interested in the accelerated reactor program and is well qualified to undertake full and complete responsibility for the design, purchase of materials for, and construction of any of the prototype reactors being considered.

Item 2: We have a staff of 1,100 people in our home office in Los Angeles and several thousand constructors in the field and we can assign an adequate number of personnel to your work immediately. Many of these are engaged in the design, procurement, and construction of nuclear energy and nuclear propulsion facilities.

Item 3: We have designed, constructed, and supervised construction of facilities at Los Alamos in amount of $25 million. We are presently designing and supervising construction of ANP facility at National Reactor Testing Station, Idaho, in amount of $40 million and proposed additional work in amount of $80 million. We have completed design and will supervise construction of $8 million nuclear energy test facility including 10-megawatt reactor for Wright Air Development Center, Dayton; are designing same type facility for Naval Air Development Center, Johnsville, Pa.; and will design one for Convair, Fort Worth. We are designing $2 million reactor facility for Curtiss-Wright Corp., and other classified nuclear facilities. We are associated with North American Aviation in

design, purchase of materials for, and construction of 100-kilowatt Consumer's Public Power District power reactor at Lincoln, Nebr., and on 12,500-kilowatt nuclear powerplant for Piqua, Ohio. We are developing master plans for nuclear aircraft facilities for Air Force and engaged by Office of Naval Research to do facilitiy planning, safeguards analysis, and site selection for Navy nuclear seaplane program. We are also engaged in two very highly classified nuclear propulsion programs for contractors of Air Force and Atomic Energy Commission.

Item, 4, we would like to assume full and complete responsibility for design, procurement, construction, and operation. We have ample financial and personnel capacity to accomplish largest program you contemplate. We will make available to you, when you require, substantiating data and figures relating to above.

Item 5, with regard your question concerning other contractors, we suggest you contact the Atomic Energy Commission where we are sure you will find the most complete list of people qualified for this class of work.

Item 6, we are delighted to receive your communication and wish to cooperate with you in whatever program is undertaken. You can contact us direct in this office or can contact Hatton C. Smith, vice president in charge of our Washington office at 1001 Connecticut Avenue NW., telephone DIstrict 7-3300.

THE RALPH M. PARSONS CO.

Re your wire May 29, in answer to your question No. 1: Since 1952 we, in conjunction with Foster Wheeler Corp. and Diamond Alkali Co., have had a study contract with the Atomic Energy Commission to investigate the feasibility and economic aspects of atomic energy as applied to power production. At present we are furnishing architect engineer services as subcontractor to Argonne National Laboratory on their low-power reactor project (ALPR).

In answer to question No. 2: Consider we are qualified for partial responsibility on subcontract basis, we are qualified for responsibility covering architect engineer services, including structural, mechanical, and electrical design of project but excluding the reactor and its specific controls.

PIONEER SERVICE & ENGINEERING CO.

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1. We have had extensive experience in the atomic energy program as prime contractor on a large project at Oak Ridge and smaller projects elsewhere as well as being construction subcontractors to Carbide at Oak Ridge, architect engineer subcontractor to Westinghouse on STR test facility at National Reactor Test Station in Idaho and also have done other work in the program.

2. We are qualified to assume full responsibility for design and construction of facilities and plants but we are not qualified to design the nuclear reactor itself nor the nuclear portion of the instrumentation and controls. We could team up with a firm specializing in these phases to do a turnkey job.

THE RUST ENGINEERING CO.

Replying to your telegram, Sanderson & Porter have performed and are performing work in the atomic-energy field. If the Government undertook to design and construct one or more additional prototype reactor projects Sanderson & Porter are qualified to assume responsibility for the design, engineering, and construction of a complete facility but do not choose as a matter of policy to design, engineer, and fabricate the reactor itself.

SANDERSON & PORTER.

Referring to your telegram of May 29, we wish to supply the following information regarding the different questions in your telegram:

1. We have had considerable experience in the atomic-energy program from the time the Oak Ridge development was started and through the subsequent development at Paducah and Portsmouth, all as outlined in the enclosed memorandum.

In regard to atomic power development, we have done the complete engineering design for the boiling water reactor now being installed at Argonne National Laboratory and have also done the engineering for the turbine installation in connection with the boiling water reactor at Arco, Idaho.

We are at the present time engaged in the design of the containment vessel for the atomic powerplant which will be installed at the World's Fair in Brussels, Belgium, for operation in 1958.

We have, in conection with 13 of our utility clients, maintained an atomic power engineering group to follow the atomic power developments.

2. We feel that we are well qualified to assume full responsibility for carrying on architectural-engineering design for the prime contract for an atomic powerplant. Due to the fact that we do not maintain experimental and manufacturing facilities, we would of course make use of consultants or subcontractors for the specific reactor problems which would require experimentation. Such consultant service could be furnished by one of the national laboratories or manufacturing concerns.

3. We would hesitate to suggest the names of other companies for these projects. We will be glad to furnish any additional information which you may require.

Very truly yours,

SARGENT & LUNDY.

I wish to acknowledge your telegram and I am glad to give you the following information in answer to your questions:

1. We do not have any experience in the atomic-energy program, although the AEC has always invited us to submit proposals in major construction work. Our subsidiary, the Ferro Concrete Construction Co. in Cincinnati have carried out several small construction contracts at Portsmouth and Fernald, Ohio.

2. We are not qualified to design or operate reactor projects but we are confident that we are well qualified to construct such facilities from designs prepared by others.

3. I am sure that the firms that we know best are well known to you, such as Babcock & Wilcox and Combustion Engineering.

Very truly yours,

TURNER CONSTRUCTION CO.

Following information in response your telegram. (1) Vitro has had long and extensive experience in the atomic-energy program. Detailed letter on background qualifications follows by special delivery. (2) We are prepared and qualified to accept complete responsibility for design, construction, and operation of prototype reactor. (3) In past and present projects have been associated with leading reactor manufacturers, Babcock & Wilcox, General Electric, Alco Products, and Westinghouse. Also familiar with suppliers of other reactor components.

VITRO ENGINEERING.

Confirming our wired reply to your June 1 telegram, I am attaching a description of Vitro projects associated with the atomic-energy program. Our applicable job history, begun in 1943 with the gaseous diffusion plants at Oak Ridge and continuing today, includes projects for the Atomic Energy Commission, its contractors and private companies playing leading roles in the development of atomic energy.

We believe the technical and administrative background afforded by this experience will enable us to make effective contributions to the accelerated reactor program under consideration. Of special importance is the overall familiarity with reactor project procedures gained in our role as nuclear consultants to Consolidated Edison Co. of New York, Inc., on their nuclear power station. In this capacity we have successively undertaken the evaluation of reactor proposals, assistance in the preparation of the construction permit application and preliminary safeguards analysis documents, are now initiating the detailed design engineering of the nuclear and conventional sections of the plant, and expect to follow through construction engineering and startup.

We wish to assure you of the high degree of interest our management has in your program, which so closely fits our experience and our objectives in the atomic-energy field.

Thank you for your interest in our organization and the opportunity of presenting this material. It is planned to contact you in the near future to determine what additional information or action may be needed.

Very truly yours,

VITRO ENGINEERING DIVISION.

HIGHLIGHTS OF VITRO QUALIFICATIONS IN THE REACTOR FIELD

The following brief discussion of typical reactor work we have undertaken presents an indication of the type and size of reactors encountered and the range of engineering services provided:

(*a*) As nuclear consultants to Consolidated Edison Co. of New York, Inc. in connection with their large scale nuclear-power project, we participated in an evaluation of several reactor types and design alternates proposed by three leading reactor manufacturers. Additional assistance was provided in the preparation of the construction permit application and preliminary safeguards analysis documents and we are now initiating the detailed design engineering of the nuclear and conventional sections of the plant and expect to continue into the construction and startup phases.

(*b*) For the past year the division has conducted a study of the power-reactor field under an industrial participation contract with the United States Atomic Energy Commission. This study concentrated on the fuel cycle, with the emphasis on fuel-reprocessing techniques and economics, and required that we keep closely in touch with all reactor types and designs currently under investigation and development for civilian power applications, and also with test and research reactor developments. These investigations are continuing under an access permit.

(*c*) For the past several years the division has been a participant in the Atomic Power Development Associates (APDA) group, spearheaded by the Detroit Edison Co., which is engaged in the development of a large-scale fast breeder reactor. Further, we have done under APDA contract, conceptual design studies of pyrometallurgical processing and remote fuel fabrication.

(*d*) We are currently preparing a conceptual design and economic analysis of two small reactors of different power level to be used as low level heat sources, under contract with the Engineering Research & Development Laboratory at Fort Belvoir, Va.

(*e*) We have recently received a contract from Lockheed Aircraft Corp. for the complete design of a multimillion dollar, two reactor developmental facility for the study of shielding and radiation effects problems encountered in nuclear-power-propelled aircraft.

(*f*) We were retained by the atomic power division of Westinghouse Electric Corp., Inc., to assist them in design studies in connection with a homogeneous power-reactor system.

(*g*) Last year, working jointly with the Babcock & Wilcox Co., we prepared a conceptual design of a novel power-reactor system which combined the features of a homogeneous reactor and a boiling water reactor.

(*h*) We have had engineers stationed at Oak Ridge National Laboratory and Argonne National Laboratory, working on the development of a homogeneous power-reactor system and a boiling water power-reactor system, respectively.

(*i*) Several years ago we were called on by the United States Atomic Energy Commission to coordinate and edit a series of engineering handbooks of reactor technology, covering reactor physics, reactor engineering, reactor materials, and fuel processing. The first edition of this series was issued in 1953.

(*j*) Under contract to Westinghouse Electric Corp. we will shortly begin the design of a complex test loop to be installed at the ETR at Arco, Idaho.

(*k*) For Alco Products, Inc. Vitro designed the APPR critical experiment facility to study specific reactor components under radioactive conditions.

(*l*) We are currently executing two contracts to provide engineering assistance to the General Electric Co. in connection with special experimental facilities for their aircraft nuclear propulsion project.

(*m*) Vitro has developed remote maintenance tools and techniques for the HRE program at Oak Ridge for Union Carbide Nuclear Co.

In addition to the above projects, Vitro has designed and engineered several major facilities, such as radiochemical separations plants, at Hanford and Oak Ridge which, by reason of their requirements for radiation shielding and remote operation and maintenance, have given us considerable experience directly applicable to the engineering of reactor installations.

Chairman ANDERSON. The hearings will adjourn.

(Whereupon, at 5:15 p. m., Tuesday, May 29, 1956, the joint committee adjourned sine die.)

APPENDIX

Statement of Atomic Energy Commission on Status of Foreign Reactor Programs, May 22, 1956

Mr. Chairman, in your letter of May 10, 1956, and in earlier meeting between the AEC and JCAE staff, the JCAE requested a status report on the foreign reactor program. The following information, prepared in response to that request, is drawn largely from unclassified publications and the visits of AEC officials to some of the nations covered.

The industrial nations of the world fall into three general classes in the development of nuclear energy:

I. *Nations with large efforts, both in weapons and in power applications.*—There are three nations whose programs are in this category: the United States, the United Kingdom, and the Union of Soviet Socialist Republics.

II. *Nations which have started or are just starting power reactor development.*—Included in this group are: Canada, France, Belgium, Germany, Italy, Sweden, Norway, Japan, and possibly others such as Switzerland and the Netherlands. Some of these nations are interested in the initial purchase of power reactors from the United States or the United Kingdom. However, all of these nations are determined for the most part to do their own work and to develop their own nuclear power economy.

III. *Nations having an interest in nuclear power but not yet sufficiently advanced in technology to go beyond the research-reactor phase.*—The other nations contemplating nuclear development fall into this grouping. Several of the smaller nations have an interest in packaged power reactors.

The status of nuclear power development in the nations of each class (except for the United States and U. S. S. R.) is summarized in the following:

CLASS I

United Kingdom

The immediate objective of the British with their Calder Hall type plants is to produce plutonium, with power as a byproduct. Four power stations, containing eight dual-purpose reactors, are being build by the United Kingdom Atomic Energy Authority as the first step toward having nuclear power supply an increasingly large part of their future power needs. The British would rather import uranium than coal and oil. They were forced to make such a decision because of their domestic shortage of chemical fuels. According to their own estimates, United Kingdom nuclear power probably will not be competitive until 1965 or later. A more detailed summary of the United Kingdom nuclear power program is contained in a classified letter of March 8, 1956, from the General Manager, United States Atomic Energy Commission, to the chairman of the Joint Committee on Atomic Energy.

The only large reactors now operating in Britain are the two air-cooled graphite-moderated Pu production reactors at Windscale. The first Calder Hall reactor will go critical early this summer and will feed the first power into the United Kingdom Central Electric Authority distribution grid on October 17, 1956. The second reactor in this first power stage will be completed about 6 months later. A net generating capacity of 75 EMW is expected. The estimated cost of this station is $46 million, or $650 per kilowatt. Three additional plants, 1 at Calder Hall and 2 at Chapel Cross, are expected to be completed in 1957–58. These are identical with the first Calder Hall power station. It is estimated that the cost of power from these plants will be about 20 or more mills per kilowatt-hour, not including credit for weapon-grade plutonium.

The second phase in the British nuclear power program consists of the construction by the CEA of three stations beginning in March 1957 with completion in late 1960 or early 1961. These are complete redesigns of the Calder Hall type

of reactor. The most recent estimates indicate that these power plants may be capable of 300 EMW per pair at a cost of $300 per kilowatt (not including U inventory). These reactors will emphasize the production of power as contrasted with the production of Pu in the Calder Hall reactors. It is estimated that the power will cost 7 mills per kilowatt-hour after plutonium credit (2 to 3 mills per kilowatt-hour), which is competitive with power from existing conventional plants, based on the British accounting system. In the United States the equivalent cost would be 10 to 11 mills per kilowatt-hour.

Construction of a third phase of 3 more nuclear power stations is expected to begin about 18 months after the start of the second phase and to be completed by 1963. The second- and third-phase nuclear power stations will be built by private industrial companies under contract with the Central Electrical Authority, which will operate the stations and sell the Pu produced to the UKAEA. The entire program—Calder Hall, Chapel Cross, and the first 2 increments of industrial installations—will, therefore, see 10 stations with 20 gas-cooled reactors under construction or in operation by the end of 1958, according to present plans. The electrical power represented by these stations will be about 2,000 MW, the cost from $600 million to $700 million, exclusive of development costs. By United States standards, these reactors do not appear "economical," though they are attractive under the United Kingdom conditions of financing and Pu pricing.

The UKAEA is also planning to build a prototype 100-EMW sodium graphite reactor which will produce power and some byproduct plutonium. It is intended that this prototype will serve as a first step in the construction of additional power reactors of this type to be completed by the CEA about 1965 and later.

The UKAEA is also building a fast reactor experiment at Dounreay which is similar to the EBR–2. This reactor is a prototype for fast-breeder power reactors which, it is anticipated, will also be built for civilian power.

The British have expressed an interest in building a nuclear-powered submarine. Under the present power bilateral agreement, there is considerable exchange of information on specific power reactor types, i. e., fast reactors, heavy water reactors, sodium graphite reactors, liquid metal fueled reactors, and gas-cooled reactors. There is also a mutual exchange of specific technical information.

CLASS II

The problems and objectives of the nations in the second classification differ significantly from those of the nations in class I. The present status of reactor development in each of these nations is summarized briefly as follows:

Canada

The Canadians now have two reactors in operation. ZEEP was the first zero-power heavy-water reactor. It is used as a full critical assembly unit. NRX was the world's first high-power, heterogeneous heavy-water reactor. It is used for testing of special fuel elements. Originally designed to use ordinary U metal fuel, special fuel assemblies containing Pu and enriched U have recently been used to compensate for loop experiments.

An improved NRX-type reactor called NRU is expected to go into operation this year. It will provide improved fuel-testing facilities. An NRX reactor using ordinary U metal is being built for India under the Colombo plan. A low power test reactor (PTR) is being considered primarily for acceptance testing of structural and fuel materials. A heterogeneous heavy-water reactor (NPD) is being built at Des Joachimes by the Canadian General Electric as a nuclear-power demonstration reactor. It will use U-oxide as fuel and zircaloy for cladding. On a long-term basis the Canadians are also considering a 100 to 200 MW low-cost nuclear-power station and several small-package power reactors. It does not appear likely that Canada will have any appreciable amount of nuclear power before 1965.

Since the signing of the bilateral agreement on June 15, 1955, there has been considerable exchange of technical information and some exchange of fuel elements for reprocessing in the two countries.

France

The French atomic-energy effort is in some respects organizationally about midway between the United States and United Kingdom in that their large reactors are being built under contract, as are those in the United States, and their research center at Saclay is Government operated like Harwell in the United Kingdom. Their first research reactor, ZOE, is at Chatillon. It is a "zero energy reactor." Saclay has one gas-cooled (CO_2), heavy-water moderated,

graphite reflected reactor (P–2) in operation and a heavy-water cooled and moderated reactor (EL–3) using United Kingdom slightly enriched uranium scheduled for completion in the spring of 1957.

The production reactor site at Marcoule is usually closed to foreigners. However, it is known that their first reactor (G–1) is an air-cooled, graphite-moderated, natural uranium reactor somewhat similar to the Brookhaven unit. It is a 20 to 30 MW thermal, 5 MW electrical reactor. It is worth noting that the power required for the air blowers is 8,000 electrical kilowatts so that the power produced supplied only about two-thirds of that required to operate the reactor. Two large pressurized CO_2 graphite moderated reactors (G–2 and G–3) are under construction, 100 to 150 MW thermal and 20 to 30 MW electrical each. With the completion of these units, by 1958, the Marcoule site will give the French three dual-purpose plutonium production reactors with power as a byproduct.

The French estimate that within 10 years they will need a source of alternative power to that provided by conventional fuels. An agreement for cooperation with the United States is now being negotiated.

The French have recently announced that a G–4 reactor will be built in Algeria and that Electricite de France will build a power reactor (EDFI) of 60,000 electrical kilowatts in the Val-de-Loire district to be completed in 1959 and which will utilize plutonium from the Marcoule reactor as fuel.

Belgium

The Belgium efforts are currently aimed at putting the Mol Research Center and its air-cooled, graphite natural-uranium reactor in operation this year and in getting the Brussels World's Fair reactor, purchased from Westinghouse, in operations in 1958. Their reactor will produce 11,500 electrical kilowatts. Their remaining program envisages a high-flux engineering research reactor at Mol for which they are currently negotiating a contract with Nuclear Development Associates for design studies. This reactor would be planned for completion in 1958. Consideration is just now being given by the Belgians to the establishment of a medical research effort at Mol, possibly including a medical reactor. A power reactor of about 150,000 kilowatts electrical output is desired in Belgium by about 1961.

West Germany

Postwar restrictions on nuclear research have delayed developments in the nuclear energy field in Germany. Germany has not yet adopted atomic-energy legislation.

In October 1955 a Ministry for Atomic Affairs was established with Fransz-Joseph Strauss as its head. The Ministry was originally organized to handle legal, economic, and financial problems related to the procurement of uranium, the use of atomic energy for trade and industry, and for general public safety. The Ministry now appears to be the central agency for all atomic-energy activities in Germany. In recent discussions Minister Strauss stated that the three steps which they plan to take were first, emphasis on training personnel; second, emphasis on designing reactors; and third, emphasis on industrial applications. Toward the first objective a request has been made to increase the number of trainees in the United States from Germany and the number of technical personnel in Germany from the United States.

Three centers will be established: (1) Reactor development school for electrical production at Munich under Dr. Meyer Leibnitz, (2) mobile reactor center at Hamburg, and (3) a research reactor center at Heilbronn. At the present time consideration is being given to the purchase of 2 pool-type reactors and 1 water boiler for these centers. Industrial companies in Germany would like to buy a Belgium (BTR) reactor for training purposes. A German-made heavy-water natural-uranium reactor with heat power of about 10,000 kilowatts is to be erected at Karlsruhe. This reactor will be utilized for research, radiation experiments, production of radioisotopes, and training of personnel. Plans are also underway for a 40,000-kilowatt (electrical) reactor to be built at Dusseldorf City, based on a design to be obtained under license from the British Babcock & Wilcox Co., using fuel from the United Kingdom. Power reactors are also being planned for Heilbronn (by 1970), Darmstadt and Oberhausen-Ruhr, the last being the location of the German Babcock & Wilcox Co. which is planning a 25,000-kilowatt natural uranium-graphite reactor and a 50,000-kilowatt reactor.

Italy

A new organization, Societa Elettronucleare Italiana, has been incorporated in Rome for the purpose of establishing a nuclear powerplant. This organization is composed of eight private Italian utility companies. They are making plans for a 10 MW heavy-water moderated natural uraninum reactor. Italian scientists and engineers have visited frequently the Norwegian and British reactors. Such visits have constituted the chief means of training Italian personnel.

Several other groups including Fiat and Societa Edison have been making studies of power reactors and are known to be interested in going ahead with reactor projects.

Uranium ore having 0.3-percent U content is available in apparently large quantities in the Piedmont region. A pilot plant for the production of uranium metal by calcium reduction is in operation. A heavy-water plant, which employs a combination of volcanic heat in the distillation process and electrolysis in the final operation, is to be constructed in northern Italy.

Italy has ordered a heavy-water research reactor of the CP–5/MIT type.

Sweden

The Swedish effort is now divided among three groups. It appears that the two industrial groups will shortly join forces with the government sponsored Atomenergi A. B. The objectives of these 2 groups envisage a series of 4 reactors: (1) The CP–3 type experimental pile now in operation, (2) an engineering research reactor currently under serious design study for completion in about 1959, (3) a heat-producing reactor for space heating for completion about 1960, and (4) a power-producing reactor for completion about 1962. All four of these reactors are based upon the natural-uranium heavy-water concept. Drawings of Swedish reactors have been supplied to United States Atomic Eenergy Commission. Early studies on ship propulsion are underway.

Norway

The Norwegian atomic-energy program has a number of Dutch personnel working on a joint Norwegian-Netherlands project (JENER) and several other foreign personnel. They have currently in operation a CP–3 type research reactor. They have under construction at Halden as a Norwegian venture, a process heat reactor for completion in 1957. This reactor is designed for 20,000 kilowatts of heat and is expected to operate initially at 10,000. It is a boiling heavy-water unit. Initial operation will be on natural uranium. Power operation will be with slightly enriched uranium obtained from the United Kingdom. The heavy water is in part from Norway and in part from the United States. Norway has recently opened negotiations for a power bilateral ultimately aimed toward ship propulsion.

Japan

Since the atomic-energy law of Japan went into effect (January 1, 1956), her atomic activities are being rapidly and more effectively organized. The major leadership in nuclear research is being taken by the Government. The major leadership in nuclear power developments is being taken by private industry.

The future industrialization of Japan, as in the past, will be directly proportional to the additional power capability that can be built and operated economically. If nuclear power is shown to be competitive with chemical fuels in power-rich countries, such as the United States and the U. S. S. R., it should have an even greater economic advantage in Japan.

The Japanese Atomic Energy Research Institute has purchased a 50-kilowatt water boiler research reactor (containing about 1.5 kilograms U–235) from Atomics International. This reactor and the second one, a CP–5 type, will be located at the AERI site at Mito (about 60 miles northeast of Tokyo).

To meet future power requirements it is necessary to continue to develop about 1 million kilowatts of electrical capacity annually, while the exploitation of Japan's hydro and coal resources is reaching the limit. Hence, it is considered necessary that power demonstration reactors be built in Japan within a few years in order to realize economical atomic power as early as possible. In this way they hope to be supplying part of their power requirements by means of large atomic plants by 1966.

Switzerland

In Switzerland private industry appears to be taking the lead. The company known as Reactor, Ltd., financed chiefly by some 130 private companies, but with

some Govrenment participation has been active for some time. No atomic-energy law currently exists in Switzerland, though the matter is now under serious study, Reactor, Ltd., is rebuilding the Geneva exhibition reactor as a research reactor. The second project of Reactor, Ltd., is a 10,000-kilowatt (heat) heavy-water testing reactor of their own design using British U and United States and Norwegian heavy water. The group has not yet done much work on power reactors and has currently devoted most thought to heavy-water natural-U cycle. However, Swiss industry is primarily interested in building reactors for export. A power bilateral is under negotiation.

CLASS III

In general, most of the nations in class III are not sufficiently advanced technically to achieve an adequate supply or substantial consumption of electrical energy through conventional means, much less to enter an active program of nuclear power development. The needs and capabilities of these nations cover a broad range and in most cases are uniquely determined by the special situations within each country.

At the upper level, for example, is India which has an ambitious nuclear energy program aimed at the production of electric power. India suffers primarily from the lack of experienced technical personnel. The acquisition and operation of research reactors will help to overcome this shortage. The Canadian Government is constructing an NRX reactor as a gift to India under Canada's Colombo plan aid to that country. The reactor will be built in Canada but some of the less technical construction work will be performed in India. Its installation will be under the supervision of Canadian scientists and technicians who will train Indians in its operation. The reactor will enable Indian scientists to launch their own studies in research on nuclear energy and its economic development. Because of the large aluvial deposits of monazite in India there is considerable interest in a thorium breeder. Both U and Th can be produced in sizable quantities from Indian monazite. Plans are also underway for the production of from 5 to 6 tons of heavy water per year as a byproduct from the manufacture of fertilizer. Rich deposits of Be ore are available and the Indians plan to export the processed material in addition to using Be in their own reactors.

At the other extreme, a country like Colombia has not developed deposits of nuclear raw materials, has very little technical manpower, and has only a limited development of conventional powerplants. In Colombia, as in so many of the other smaller countries, the interest in a nuclear reactor stems both from the desire for prestige and from recognition of the need to gain experience in this field. Several of these countries have expressed interest in small packaged power reactors such as the APPR.

A private United States utility which operates in a number of Latin American countries, American and Foreign Power, Inc., is currently negotiating for the purchase of 3 different 10,000-kilowatt nuclear powerplants for installation in 3 of the countries it serves.

Between these two extremes are many other countries, some of which have research bilaterals with the United States. One of the major problems for these countries is the dominant position of foreign exchange and the dependence on United States dollar aid.

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